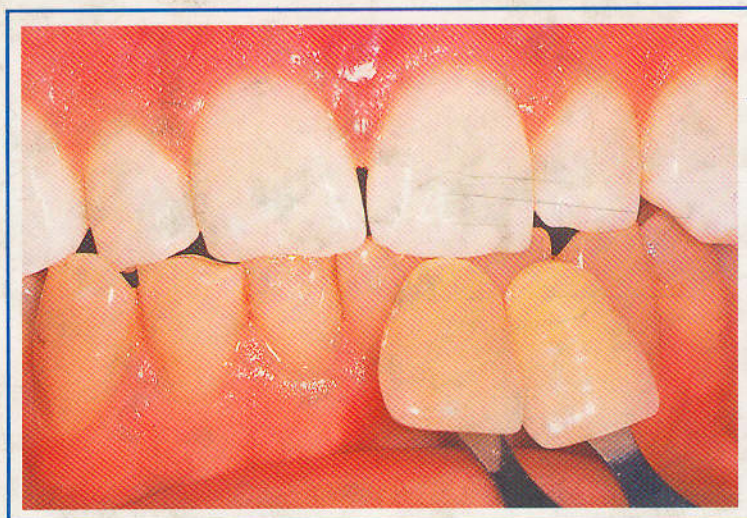
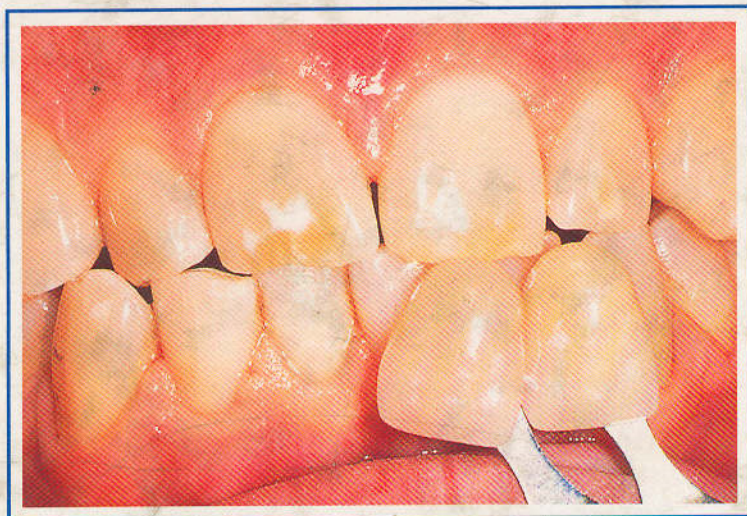


COLOR ATLAS OF TOOTH WHITENING

Gerald McLaughlin/George A. Freedman



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Book Editor: Gregory Hacke, D.C.

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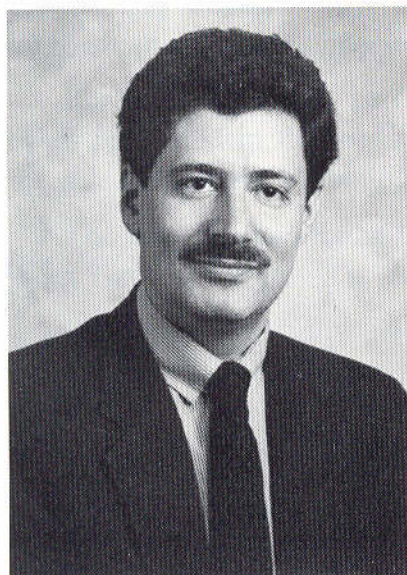
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Dedication



This book is dedicated to my wife Judi who has taught me that today, well lived, makes every yesterday a dream of happiness and every tomorrow a vision of hope.

Gerald McLaughlin, D.D.S.



The opportunity of devoting time to a project such as this is largely a function of the support, cooperation, and understanding of the author's immediate family. The encouragement and help that I have received from Dr. Fay Goldstep (my wife), Judy (my daughter), and my parents have been unwavering. It is to them that I dedicate my efforts.

George A. Freedman, D.D.S.

NOTICE

Dentistry is an ever-changing science. As new research and clinical experience broaden our knowledge, changes in treatment are required. The editors and the publisher of this work have made every effort to ensure that the procedures herein are accurate and in accord with the standards accepted at the time of publication.

Acknowledgements

From time to time, an emerging modality is rapidly and widely embraced by the dental profession. Certainly, this has been the case with tooth whitening. Within a year of its introduction, more than half of the North American dental community had made tooth whitening a routine part of their armamentarium. Many people have worked diligently over the years to develop the materials and technology that have made tooth whitening possible. The concepts and methods involved had many parents, all of whom can be proud of their various roles. The early contributors to recent advances include H. Pearson, E.B. Nutting, and G.S. Poe. Ron Feinman, Ron Goldstein, and David Garber pioneered the modality of bleaching teeth, and helped to develop the public demand for whiter dentition.

John Munro was instrumental in recognizing the potential that existed in the whitening system. Dan Darnell helped in the creation of the now common plastic/foam whitening tray. Van Heywood and Harald Heymann provided early scientific support, and Jack Lemons is continuing material testing and evaluation.

In this book, Sidney Markowitz and Steven Valadez have contributed to the sections on imaging and case histories, respectively. Stephane Schwatz was kind enough to provide pictures of variously discolored teeth, as was Maury Krystel, who also gave us valuable comments on the manuscript. Other photographs were provided by Dan Fischer and Pat Anne Irene Doro.

Karen Canning and Leonor Bussieres were very helpful with the clinical aspects of the cases presented in this book. Andre Dagenais assisted in the development of the technique for selective tooth whitening.

The task of assembling the current state of the art into a single book fell largely on Dr. Greg Hacke, our editor at IEA Publishers, to whom we are greatly indebted.

We would especially like to thank Gordon Christensen for both his introduction and his work; his tireless evaluation and testing have helped to pave the way for better understanding.

Gerald McLaughlin, D.D.S.
George A. Freedman, D.D.S.

Foreword

I have been involved with bleaching teeth in the dental office for over 25 years, and this concept has been an excellent method to improve patient self-esteem and confidence. However, over the many years that this technique has been a part of my practice, there have been numerous limitations noted. Teeth bleached with light and or heat to accelerate hydrogen peroxide activity require tedious and often painful procedures. Rubber dam placement is uncomfortable at best, even when it is placed very carefully. Ligation of the rubber dam is time consuming and painful. Having a rubber dam in place for 30 or more minutes each time over several appointments is not pleasant. Hydrogen peroxide leaking onto gingival tissues is irritating and painful. Post-operative heat/cold sensitivity has been common for up to 10 days after each in-office bleaching procedure.

From a practice administration standpoint, in-office bleaching requires dental auxiliary activity to make the procedure an equitable one financially and to keep the cost low enough for patient acceptance.

Re-bleaching to remove recurrent coloration required at least an appointment or two on a nearly annual basis: only the most committed patients wanted to return for re-bleaching.

After accomplishing hundreds of in-office vital tooth bleaching procedures, I could summarize my feelings by saying that the bleaching is highly desirable, but the end often was not justified by the means. Therefore, the technique and its benefits were often denied in my own practice to older patients and to those with low pain thresholds.

A new form of bleaching, providing the benefits of the past generation of bleaching procedures without most of the described negatives, has created a significant impact in the dental profession and those we serve. Bleaching teeth outside of the dental office using carbamide peroxide has caused a revolution in vital tooth bleaching. Now the benefits of bleaching are available to any interested person.

Clinical Research Associates initiated an in-depth study of carbamide peroxide as a tooth bleaching agent after the introduction of the concept by Omnii International and the subsequent marketing of many products (*CRA Newsletter* July 1989, and December 1989, *J Dent Res* 69:303, *IADR Abstract* 1558, 1990). The research was directed toward the potential negative

influence of these bleaches on dentin, enamel, and tooth restoratives. Basic science research including cell culture, scanning electron microscopy, qualitative analysis, and other projects were completed. It was found that some of the products varied significantly in their active ingredient content, pH, viscosity, chemical activity, and other characteristics. As a result, they also varied in their effectiveness. Accompanying these basic science studies were in-depth clinical observations on the influence of the bleach on various types of intrinsic stains, and the potential side effects. It was found that the materials bleached brown-orange-yellow intrinsic stains very well, but that they were much less effective on blue-gray stains. The stains of age disappeared with amazing speed. However, some negative side effects were also apparent in about 5% of patients. These included: sensitive teeth; irritated gingiva; sore throat; occlusal or TMJ problems related to wearing the tray; and minor changes in some restorative materials. All of these side effects were considered to be negligible when compared to the benefits of the at-home bleaching concept. The procedure works; and in general it appears to be non-damaging!

Long-term research is mandatory to determine any negative influence of these materials over many years and to observe when re-bleaching will be necessary. It is unknown at this time if anything negative will appear. However, major problems seem to be improbable.

Bleaching teeth at home is a wonderful adjunct to esthetic dental practice. It allows simple, relatively fast, non-painful bleaching of teeth at an affordable cost. It allows changing the color of aged teeth *before* placing a few crowns or an isolated fixed prosthesis. It will reduce the quantity of restorative procedures that have been done primarily for esthetic reasons.

As with any new procedure, I urge our caution as clinicians. Informed consent forms should be signed by patients. I suggest close supervision of bleaching procedures. If the new bleaching concepts look as good five years from now as they do at the present time, this new concept is one of the most important advances in esthetic dentistry in the past decade.

Gordon O. Christensen
DDS, MSD, PhD

Introduction

In 1985, Dr. John Munro of Crossville, Tennessee, had been experimenting with solutions to whiten teeth. With his chemistry background, he had the idea that there were solutions available which could safely and effectively whiten teeth for patients.

Over a period of two years, Dr. Munro treated about 40 patients with different solutions, documenting the clinical results of each solution. In 1987, Dr. Munro presented his ideas to Omnii International, a pharmaceutical and dental company. A group of 35 dentists was recruited in 1987 and 1988 to treat patients with different materials, methods and solutions.

Hydrogen peroxide and carbamide peroxide solutions of different strengths and viscosity were used and evaluated for effectiveness, side effects, and safety. During this time a major chemical/plastics company conducted tests to evaluate the action of solutions with different types of plastics. It was noted that some solutions containing phosphoric or citric acid reacted with plastics to release toxins. What some clinicians thought were soft tissue reactions to the solutions were in fact side effects from the release of these toxins into the surrounding soft tissue area. Also, it was noted that thicker solutions elicited more soft tissue problems because these materials were too thick for sulcular fluids to flush out.

In the middle of 1988, a solution was developed that was stabilized by a natural food additive, and the heating and cooling process of perhydrol urea. There was no need with these solutions to add phosphoric or citric acid to stabilize the solution. The solution greatly reduced the incidence of gingival irritation, sensitivity, and enamel change. Also, the solution did not have a reaction with the plastic materials used to make the mouth trays.

During the initial marketing of the product, White and Brite, testing continued to find better ways to deliver the solution to the tooth surface. The efficacy of the entire system was greatly enhanced with the addition of a foamed matrix material which fuses with a poly-resin material to form a thin, sponge-like mouth tray. This material physically maintains the solution in contact with the tooth structure to accelerate the whitening process. The cellular nature of the foamed liner provides a spacer or pad between the molded tray resin and the teeth. The older, less sophisticated technique utilizing coping plastic vacuformed over a stone model of the patient's teeth allowed minimal space between the tooth and the tray. The close adap-

tation of the tray material to the model would sometimes have the same effect found when two panes of glass are pressed together; the solution intended to whiten the teeth would be squeezed out.

The matrix also acts as a stress breaker for orthodontic or temporomandibular sensitivity. Discrepancies between the model surface and the patient's teeth are less likely to cause discomfort when buffered by the spongy matrix material. In addition, the matrix eliminates the tightness of fit patients sometimes feel wearing a tray fabricated without this material.

The surface of the matrix contains thousands of tiny dimples which serve as reservoirs of whitening solution. The solution oxidizes for a longer period of time trapped in these pools and is also less likely to be washed out by salivary flow and squeezing of the tray by tongue and cheek movement. This feature allows the fastest and most comfortable whitening of patient's teeth of any method available today. This matrix can be selectively applied to specific teeth which need more whitening effect by lessening the efficiency of the whitening in areas of the tray where matrix is absent. A lesser known feature of the tray is its ability to withstand autoclave sterilization, as may be required by OSHA in the future for all intraoral prosthesis delivered by the dentist.

It should be noted that some of the early foam matrix materials reacted with the solution, causing it to deteriorate within the custom tray. The present insert material (called X-Cell) is safe, and will not deteriorate or release toxins. The resulting combination of the porous liner with a polyresin tray has produced a safer, more comfortable, more efficacious delivery system than ever before possible.

Daniel Darnell
DMD

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Chapter 1

Tooth Whitening as a Treatment Modality

As the techniques and materials available to dentists have improved over the past few decades, better and more conservative restorations have become possible. Extensive preparation and tooth destruction have given way to a genuine concern for the preservation of tooth structure. Most recently, much attention has been devoted to the esthetic aspects of dentistry and the patient's concerns for appearance. The past three decades have been the most dynamic period that dentistry has ever known.

As the population's dental awareness has grown, so has its demand for a natural (or preferably supernatural) smile. The one inescapable fact in the study of tooth whitening is that patients are very eager to have whiter and brighter smiles. The cultural environment encouraged by toothpaste advertisements and Hollywood, and bolstered by the personal need to appear healthy and young, deems that discolored or dark teeth are no longer socially acceptable. Patients are therefore seeking, and even self-administering, many exotic and questionable procedures to achieve the whiter smiles they desire. It is the dentist's responsibility to supervise those patients who seek to undergo a whitening treatment to ensure the maximum cosmetic benefit within the boundaries of oral and systemic health.

Historical Background

The desire for whiter teeth is not completely a recent phenomenon. In Biblical times it was considered "that the person who whitens the teeth of his neighbor is better than the person who gives him milk to drink."¹ Theophrastus of Ancient Greece wrote in the third century B.C. that it was "considered a virtue to shave frequently and to have white teeth." If there was any attention paid to dental hygiene and appearance during the middle ages, there is no surviving documentation. Life spans were short, education was minimal, and the primary concerns were those of survival, food, and shelter.

Guy de Chauliac, a 14th century surgeon, commented extensively on dental conditions and produced a set of rules for oral hygiene which included the following tooth whitening procedure: "Clean the teeth gently with a mixture of honey and burnt salt to which some vinegar has been added." His texts were considered authoritative for nearly 300 years.

The following era of dentistry brought the study of dental anatomy, of oral disease, and a great interest in the prosthetic replacement of teeth whose loss could not yet be avoided. As the science of dental technology expanded, dentists were better able to replicate both form and function. Then, in the nineteenth century, dentistry began its recognizably modern procedures of restoring carious, and even infected teeth. This resulted in patients retaining their teeth for a greater portion of their lives, and furthermore, an expectation that these older teeth could be made visually acceptable.

The demands of patients, combined with a rapidly advancing study of medical chemistry, resulted in the first vital tooth bleaching agents and procedures. Chapple proposed oxalic acid as the material of choice in 1877. Shortly after, Taft suggested calcium hypochlorite as an effective whitening solution. The first mention of peroxide as a whitening agent was over 100 years ago; in 1884 Harlan published a report about a material that he named hydrogen dioxide.²

Some of the more interesting bleaching technique proposals included electric currents and ultraviolet waves (Rossental) at the turn of the century. Obviously, neither of the above really caught on with the mainstream dentist.

Acid dissolution of brown fluoride stains was yet another approach to certain discolorations. This technique was first documented by Kane in 1916. The technique involved the use of 18% HCl to dissolve the superficial layers of enamel. Further investigations were made in this area by McCloskey in 1984.³

In 1918, Abbot pioneered the dental effects of superoxol.⁴ He found that while the chemical was suitable for bleaching teeth, its action could be greatly enhanced by the addition of heat and light. Some of the bleaching techniques that are in use today are actually based on Abbot's findings.

While the earliest attempts at bleaching non-vital teeth were made at the end of the 19th century, no major developments came until the 1950's. As endodontic therapy became part of the regular dental armamentarium, increasing numbers of functional, but unesthetic teeth led dentists to look for new tooth whitening techniques. In 1958, Pearson reported on the use of superoxol sealed within the pulp chamber. He stated that within three days, the oxygen releasing capacity of the solution had whitened the experimental teeth to some degree.⁵

By 1967, Nutting and Poe had refined this method to what has become known as the "walking bleach."⁶ In this method, a 30% mixture of superoxol and sodium perborate was left in the pulp chamber for up to one week. This technique provided the most dependable treatment modality of the time for tooth bleaching, but its use was obviously limited to endodontically treated teeth.

It is only in the last decade that dentistry has finally begun to provide patients with reasonable methods for vital tooth color modification. In 1989, a new procedure was developed whereby a stabilized solution of carbamyl peroxide or perhydrol urea is placed in a molded tray, which the patient places over his teeth for hours at a time. This gentle solution works to gradually whiten the teeth in a much more predictable, safe manner than the previous bleaching methods. The distinction between the techniques is so great that we have chosen

in this book to refer to the new technique as "tooth whitening" rather than "tooth bleaching." Far-fetched as it may now seem, prior to the new vital tooth whitening procedures, some dentists in their frustration actually recommended the removal of healthy pulp tissue for the sole purpose of placing bleaching solutions inside the chamber of severely discolored teeth.⁷

As the dental awareness of the general population has increased, fewer patients are presenting with individual anterior teeth which are endodontically discolored. Now, the most common esthetic problem is a global discoloration or darkness visible on all the anterior teeth. These teeth are nearly always vital. The desired change is often a moderate modification such as lessening the yellow or gray component of the overall color scheme of the teeth.

When we consider that the teeth are vital, and therefore more likely to be sensitized by any treatment, and that the desired color change is not a radical one, there is no need to use the caustic materials and extensive procedures associated with various bleaching techniques. The safe whitening of vital teeth requires a mediating material that is acceptable to both the dental structures and the surrounding tissues; an agent which is both non-caustic and non-toxic.

Feinman et al. have stated that bleaching vital teeth is more difficult than treating non-vital teeth.⁸ While this was true for the peroxide/heat/light bleaching procedure (Feinman et al.), it is now precisely the opposite for tooth whitening. It is not only much easier to whiten vital teeth rather than non-vital ones, but it is even easier to whiten the entire anterior arch, than to work with a single discolored non-vital tooth. This may account for the immediate acceptance of outpatient tooth whitening by the dental community.

Tooth Whitening Timeline

Unsuccessful Bleaching

Middle Ages

Initial Attempts At Bleaching

- 1877 Chapple - oxalic acid
- 1888 Taft - calcium hypochlorite
- 1884 Harlan - hydrogen dioxide
- 1895 Electrical currents

Non-vital Bleaching Initiated

- 1895 Garretson
- 1911 Rossental - ultraviolet waves
- 1916 Kane - 18% hydrochloric acid

Modern Bleaching Techniques Begin

- 1918 Abbot - superoxol and heat

Successful Non-vital Bleaching

- 1958 Pearson - intrapulpal bleach
- 1967 Nutting and Poe - walking bleach

Modern Techniques

- 1978 Superoxol heat and light
- 1989 Munro - out-patient tooth whitening

Difficulties with Current Techniques

The two most recent techniques for the chemical whitening of teeth are the superoxol/heat/light bleaching system (sometimes referred to as "power bleaching"), and the carbamide peroxide home whitening treatment. Each modality has certain inherent difficulties associated with it.

Superoxol/Heat/Light Bleaching

The major problems with this technique are due to the heat and light that are required to activate the superoxol to an acceptable reaction speed, and the corrosive nature of the solution. The recommended operating temperatures are up to 60° C (140° F) for vital teeth, and up to 71° C (160° F) for non-vital teeth. This is well beyond the comfort range for facial skin. The rubber dam will provide some thermal protection, but over a long appointment the discomfort may be considerable.

The eyes also have to be protected, and the patient is usually asked to wear goggles. Without eye protection, the patient must not move from the original position, or the bright light will bother his eyes. Due to the positioning of the light, directly in front of the face, the patient is not able to do any activity such as reading to relieve his boredom while in the chair for extended periods. It is therefore advisable to have the dentist or an auxiliary monitoring the patient throughout the procedure.

It is suggested that the active part of the session be at least 30 minutes (up to 1.5 hours). With the preliminary and post-bleaching steps, this can easily stretch to an hour. Unfortunately, it is relatively difficult and uncomfortable for the patient to remain essentially still for that period of time.

The discomfort of the actual procedure becomes magnified by the number of visits required to achieve a recognizable result. It is estimated that four to ten appointments are necessary for most patients. Even though anesthetics and tooth reduction are not required, obviously this type of treatment sequence cannot be lightly undertaken.

While the need for a rubber dam, and the associated clamps, may make patients request anesthesia, it is imperative that the teeth not be anesthetized during the procedure. If anesthesia were to be administered, the dentist would run the risk of raising temperatures in the pulp beyond physiologic limits. Even with full sensitivity, there is always the risk that a patient in their exuberance to achieve the "perfect smile" may not inform the dentist when the tooth temperature becomes dangerous. In addition to the normal time associated with proper placement of a rubber dam, the recommended floss ligation around each individual tooth to be bleached is both time consuming and unreliable in the hard-to-reach interproximal areas. Still, these procedures are essential since even a slight discrepancy in the fit of the rubber dam can result in the superoxol seeping into the mouth during treatment.

Even after all this effort, the results are often less than fully satisfactory. In this matter, the ultimate judges of bleaching are the patients who have undergone treatment. While dentists may be very excited and content with their bleaching results, patients have not always

concurred. In one study surveying the patient's assessment of the value of bleaching, Reid found that approximately half the procedures were considered unsuccessful.¹⁰

Morrison reported on the patient's opinion regarding vital tooth bleaching.¹¹ He wrote that while a majority agreed that there was a definite color improvement immediately after the final bleaching appointment, 50% felt that their tooth coloration had not remained satisfactory in the time period following their last bleaching treatment. This raises the question of whether enamel dessication (which causes a whitish frosty appearance) contributed to the initial positive remarks about color immediately after the final bleaching appointment. Furthermore, 72% of the respondents reported dental sensitivity to temperature changes for hours, days, or weeks after the termination of treatment.

With any procedure that alters the shade of teeth, the patient should be warned prior to commencing treatment that it is likely that all the anterior composite restorations will have to be redone upon the completion of the bleaching. The restorations that were placed to match with a darker dental environment will no longer blend in when the surrounding natural teeth are bleached. There is the additional problem of damaged surfaces of the restorative material, since the action of highly concentrated peroxides and heat is particularly caustic.

Perhydrol Urea Home Whitening

The most likely difficulty to be encountered with this type of treatment is a lack of patient cooperation. Obviously, if the patient does not wear the tray containing the whitening material as instructed, whitening will not be achieved. Also, the tray must be well constructed; otherwise it will cause gingival irritation. Occasional transient sensitivity has been reported.

Dangers in Current Techniques

Superoxol/Heat/Light Technique

The prospect of a treatment posing danger to a patient or to the oral environment is of particular concern when embarking on an elective procedure. The corrosive nature of superoxol and its potential deleterious effects on various tissues are a definite drawback to the superoxol/heat/light bleaching system.

The tooth, which is more intimately and deliberately exposed to the bleaching agent than any other tissue, is the most at risk. The concerns about chemical and thermal intrusions on the pulp are not without foundation. It has been demonstrated that 35% hydrogen peroxide, alone in combination with heat, caused the obliteration of odontoblasts, hemorrhage, resorption, and inflammatory infiltration.¹² While the pulpal changes appeared to be reversible after sixty days, there was no absolute indication that long term damage was not sustained.

In an earlier study, Cohen found the bleaching of vital teeth to be harmless to the pulp. Unfortunately, it appears that the differences between the Cohen study and the Seale study may be due to the fact that Cohen worked with bicuspid, whose enamel to pulp distance is twice as great as that of the central incisors. Furthermore, his findings may not have any

direct application to normal clinical practice, since he bleached the teeth for a total of only 45 minutes on the buccal and 45 minutes on the lingual over three sessions. This is much shorter than the recommended times for vital bleaching today.

In addition to the potential pulpal problems, both 35% superoxol and heat can cause or aggravate hypersensitivity of the dentin. It is for this reason that the presence of dentinal sensitivity is considered a contraindication to vital bleaching. Since dentinal tubules provide a readier conduit from the tooth exterior into the pulp than the enamel, any difficulties created by the passage of peroxide or heat penetration through enamel indicate the likelihood of even greater problems when these materials are applied to dentin.

Even enamel, the hardest and densest of the dental tissues, is not immune to the actions of 35% hydrogen peroxide. Titley et al. found that an etched enamel surface that was immersed in the Superoxol solution (without heat) showed an increased porosity after as little as ten minutes.¹⁴ In light of this, the wisdom of extensive bleaching procedures with caustic agents such as 35% hydrogen peroxide, which may total 500 minutes or more over several appointments, should be re-examined.

Should the rubber dam leak, or any superoxol accidentally splatter onto the gingiva, cheeks, tongue, etc., the resulting chemical burn will remain for several days. It is very important that the rubber dam placement be close to perfect in order to avoid almost certain discomfort to the patient.



Fig. 1-1

The patient (as well as the dentist and staff) should wear protective goggles throughout the bleaching procedure. The remote possibility exists that a drop of superoxol will splash into the eyes, causing not only discomfort, but possibly long-lasting damage. Wrap-around goggles are the best choice of eyewear for the patient.

The chances that the solution will spill onto the exposed skin of the face or hands is everpresent. If immediately rinsed, the result is usually just a white patch which gradually returns to normal color in a few hours. If not quickly rinsed off, however, the liquid can leave a nasty white burn that will itch initially, and then form a scar as the burnt tissue sloughs off.



Fig. 1-2

It is therefore a good idea to cover all the exposed skin on the patient's face and neck with a non-permeable material that will contain the 35% hydrogen peroxide. Naturally, the dentist and staff must be adequately protected as well. If the peroxide drips onto the patient's clothing, it will instantly bleach any area that it has come into contact with, ruining the garment.

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Chapter 2

Tooth Whitening: The Next Generation

The Safety of Tooth Whitening

One of the most important concerns for any new dental procedure is its safety. The dentist must have absolute confidence and security in the dental treatments being recommended to his patients.

Safety is normally established in one of two ways: the product can be tested on animals in order to predict its toxicity in humans, or in the case of a material that has previously been used for human treatment, the record of the product can be examined for deleterious side effects.

As may be expected, some concerns have properly been raised regarding the safety implications of vital tooth whitening. It has been implied in the most general of terms that carbamyl peroxide* may be toxic, dangerous, and oncogenic, but no applicable scientific evidence has been advanced to support these views.^{1,2} The issue has been further clouded by assertions that dentistry has no experience with these whitening materials. All of this ignores the scientific data that has been recorded over the last forty-five years. In fact, both animal and human studies, short and long-term, have evaluated the question of the safety of carbamyl peroxide in the oral cavity.

The testing revealed that carbamyl peroxide not only promotes gingival healing, but is actively antiplaque in nature and may be anticariogenic. It is true that the focus of the carbamyl peroxide testing in past years was to evaluate the material as an antiseptic (and not as a tooth whitening agent), but the intraoral conditions under which the tests were accomplished are identical to the situations that are present with whitening procedures.

Carbamyl peroxide is not a substance new to dentistry, nor was its development for dental purposes accidental. Aqueous hydrogen peroxide has long been used by the dental profession; its lack of toxicity and minimal side effects, combined with both cleansing and bactericidal properties, made it particularly attractive for intraoral use. A major flaw in the character of hydrogen peroxide is its extremely rapid breakdown upon contact with body tissues, a reac-

* The terms carbamyl peroxide, urea peroxide, and perhydrol urea have often been used interchangeably in the past by various authors.

tion that is greatly accelerated by the enzymes peroxidase and catalase, which are commonly found in the body. The search for improved materials led to the investigation of more stable and longer acting peroxides.³

Carbamyl peroxide was determined to have a much slower rate of reaction, especially at room and oral temperatures (hydrogen peroxide in warm concentrated solutions lacks stability). The carbamyl peroxide was found to be active after twenty minutes of body tissue contact. The foaming that is observed at the initial application (or reapplication) of whitening solutions is an oxygenated foam resulting from the catalysis of the peroxide product. When the peroxide is held to intraoral surfaces by a glycerin solution, the effective reaction time is significantly prolonged.

Ambrose reported favorably on the use of carbamyl peroxide in the cleansing of teeth prepared for restorations.⁴ Arnim recorded the improvement in plaque control provided by carbamyl peroxide in anhydrous glycerol; in the absence of any other means of hygiene, four minutes of rinsing per day provided significant plaque reduction with no negative side effects reported.⁵

Manhold evaluated four commercially available oxygenating agents as applied to wounded rat tissue. The oxygenating agents all helped to promote faster healing than would be expected normally.⁶ Of all the agents tested, carbamyl peroxide offered not only the fastest, but the most complete healing.

In 1982, another rat study determined that the anticariogenic effectiveness of the oxygenating topical agents was related to their ability to release active oxygen rather than their ability to neutralize plaque acid.⁷ Carbamyl peroxide was found to be highly effective in reducing plaque accumulation and caries incidence.

Carbamyl peroxide has even been tested with neonates. It was used to treat oral candidiasis of the newborn and was found to be very effective and without adverse effects.⁸ A 10% preparation of carbamyl peroxide in anhydrous glycerin is equivalent in action to 3% aqueous hydrogen peroxide, yet far more stable and predictable.

In the following studies, one of the most important points to note is the total time of experimental oral contact with the carbamyl peroxide. This can help the dentist to establish whether the times that he recommends for the complete home whitening procedure fall within the acceptable established and researched parameters. Currently available techniques require from 40 to 300 hours of oral exposure over a period of several weeks.

Williams advocated the use of carbamyl peroxide against pharyngeal and throat infections.⁹ The total contact time over one week was about 10 hours, and to ensure that the material was adequately distributed, the patients swallowed it after gargling. It was observed that the minimal side effects were transitory, that the treatment was analgesic, and that tissue irritation was reduced.

The clinical effectiveness of carbamyl peroxide in reducing plaque and gingival inflammation was researched with institutionalized patients by Zinner et al.¹⁰ The total treatment time was 15 hours over four weeks. No side effects were reported.

In the course of selecting an oral hygiene supplement for the severely handicapped, carbamyl peroxide was used as a rinse five times per day for three weeks.¹¹ Even when the formula was used at twice the recommended dosage and frequency, no irritation or inflammation was produced in the subjects.

Fogel and Magill reported on the application of carbamyl peroxide in anhydrous glycerol for orthodontic caries prevention.¹² Seventy full-banding patients participated in this study for **periods ranging from two to three years**. The material was applied four times daily, and patients were instructed not to rinse afterward, resulting in an effective tissue-contact time of up to two hours per day. The total exposure over the entire orthodontic treatment time was 1500-2300 hours per patient. The sequelae were positively anticariogenic, and there were no deleterious side effects observed.

In 1971 Shipman investigated the effects on the gingiva of an 11% carbamyl peroxide gel solution over a period of one month (11 hours of tissue contact time) and pronounced the material safe.¹³ Kaslick evaluated the effect of brushing a carbamyl peroxide into the gingiva in order to deliver the material into the sulcus.¹⁴ The 45 hours of tissue-contact time over three months significantly reduced plaque scores when compared to brushing with a control toothpaste. In 1976, a recommendation was made that carbamyl peroxide should be considered as a routine oral hygiene adjunct.¹⁵ In another study, sixty orthodontic patients rinsed with carbamyl peroxide over a period of three months (90 hours of tissue exposure). Significant plaque reductions were observed and no adverse reactions were noted.¹⁶ Carbamyl peroxide played a significant role in reducing gingival inflammation and gingivitis in a study which involved a tissue contact time of 33 hours over twenty days.¹⁷ No side effects were observed in any of the subjects. Given the above studies, and others that have reached the same conclusions, it would appear that the safety of 10-15% carbamyl peroxide in anhydrous glycerin is well established, and that it does not pose any threat, local or systemic, to the healthy patient.¹⁸⁻²⁴

Thus, although the home tooth whitening system is a new dental service, the safety and efficacy of the materials used in the technique are actually well documented. It is an impossibility for any new modality to be created with a history of safety, but the home bleach technique comes as close to that concept as possible.

Long Term Stability of Tooth Whitening

It is difficult to evaluate the long term stability of any procedure which is still new. The most that can be said about tooth whitening is that after the first two years there has been very little color relapse noted. This is particularly encouraging since a number of the technique innovations that have been recently instituted were not even available for those early cases.

It is self-evident that certain deleterious habits such as smoking, drinking coffee or tea, and chewing tobacco may cause the teeth to discolor more rapidly, and should be avoided. A meticulous regime of oral hygiene on the patient's part will also assist in maintaining the

whiteness of the teeth for a longer period. Thankfully, it is usually easy to gain improved home care after whitening procedures, since the patient becomes acutely aware of the benefits of a healthy smile. A color evaluation as a part of the routine checkup will make these appointments more important to the patient and increase recall cooperation. This is also a time when they can be reminded of the importance of regular dental check ups and professional monitoring. The patient must be made aware of the fact that while his teeth are more esthetic, they are no more resistant to decay or periodontal problems than they were before.

The nature of tooth whitening is such that even if a gradual color change is noted at some point after the initial procedure, it is a simple matter to retreat the teeth for several days or hours (perhaps using the original flexible tray) to re-achieve the original post-treatment coloration.

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Chapter 3

Discolored Teeth

Indications

The only necessary indication for tooth whitening is the patient's desire for lighter teeth. The choice of the particular whitening technique used will depend upon the specific etiology of the discoloration. Obviously, for instance, non-vital bleaching techniques should be reserved for non-vital teeth.

Contraindications For Tooth Whitening

The only contra-indications for vital tooth whitening occur with pregnant or nursing mothers or persons allergic to any of the components. The heat/peroxide vital tooth bleaching technique should be avoided on teeth with large pulp chambers or which have exhibited sensitivity.

While not actually a contra-indication to treatment, one factor which may limit success is the degree and quality of the discoloration. In all cases, if the teeth are extremely dark, the whitening procedures may need to be supplemented by other restorative procedures such as porcelain veneers. This seems to be particularly true of stains in the gray/blue range which do not respond to whitening as well as stains of a yellow/brown nature.

Differentiating Stains

Differentiation of the quality and cause of the stain is of more than academic interest. Knowledge of the etiology of the dental staining allows the dentist to better plan the technique to be used in the whitening procedure, as well as to more accurately predict the outcome of the treatment. Staining and discolorations of teeth are caused by many factors. Traditionally, tooth discolorations are divided into two main categories—extrinsic and intrinsic stains.

Extrinsic Stains

Long chain polysaccharides and proteinaceous materials create a tenacious coating on the exposed surfaces of teeth called the pellicle. The pellicle is easily stained, with the most severe stains occurring along the gingival margin and interproximal areas which are less accessible to toothbrushing.

The pellicle is easily stained and may display many colors ranging from white to red to green and can become extremely opaque depending on the source of the pigmentation.^{1,2}

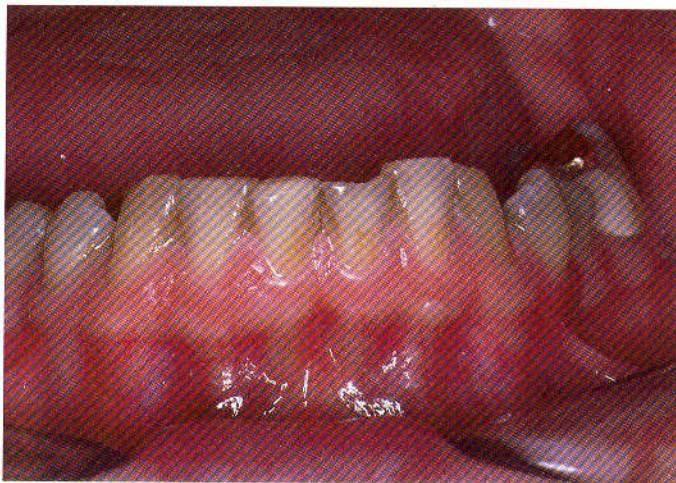


Fig. 3-1

Treatment: *Extrinsic staining is routinely removed during a standard prophylaxis. Patients are capable of removing this layer on a daily basis, and should be taught how to use their toothbrush in order to achieve maximum results. On occasion, it is necessary for patients to utilize toothpastes with a relatively high index of abrasion, or even a medium to hard bristled toothbrush. Most often, simple persistence with a soft brush and low abrasive toothpaste is all that is necessary.*

Intrinsic Stains

Intrinsic stains are not such an easy matter. These stains are the result of color changes of the internal structures of the teeth caused by factors of either systemic or local origin.³ Intrinsic stains are not only more difficult to treat, but because they are distributed throughout the tooth, they are more apparent than many extrinsic stains. With the advent of modern tooth whitening procedures, most intrinsic stains can be removed. Those situations which are not treatable by the tooth whitening procedures can be esthetically improved through the use of porcelain veneers, porcelain crowns, or bonding procedures.⁴

The difficulties in tooth whitening, as well as the expected degree of perfection from the whitening procedures, are dependent upon the type of discoloration in question. We can generally divide the intrinsic stains into two major categories: those caused during odontogenesis and those occurring post-eruptively.

During the odontogenic period, teeth may incorporate discolorations into the enamel or dentin through a change in quantity or quality of these tissues, or by the addition of pigments to their structure. During the post-eruptive period, the teeth can become intrinsically discolored when discoloring agents are integrated into the hard tissues either from the pulp chamber or the tooth surface.⁵

Intrinsic Discolorations Created During Odontogenesis

Alkaptonuria. Alkaptonuria is also known as phenylketonuria and ochronosis. It is a recessive genetic deficiency resulting in incomplete oxidation of tyrosine and phenylalanine, causing an increased level of homogentisic acid. This condition sometimes causes a dark brown pigmentation of the permanent teeth.⁶

Treatment: *Tooth whitening can lessen or even eliminate the discolorations. In severe cases the teeth may need additional esthetic procedures to achieve perfection.*

Amelogenesis Imperfecta. Generally considered a genetic defect, this condition affects both the primary and permanent dentitions.⁷ The most common modes of inheritance are either autosomal recessive or autosomal dominant. The category of amelogenesis imperfecta can be further subdivided into three groups: hypomaturation, hypocalcific, and hypoplastic. There is great variety of appearance displayed by these groups, both between the groups and even within each group.

Hypomaturation. The enamel has chipped away from the underlying dentin. In the hypomaturation type, the enamel shows an autosomal dominant mode of inheritance. (From Ishikawa's *Color Atlas of Oral Pathology*. Ishikawa G, Waldron C. St. Louis: Ishiyaku Euro-America, 1987.)

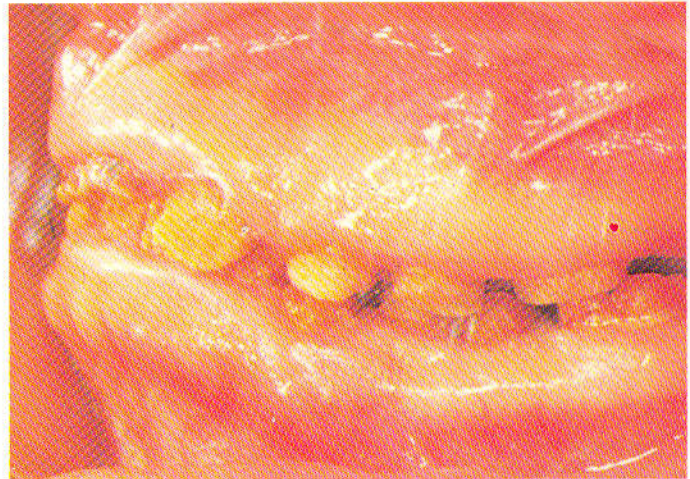


Fig. 3-2

Hypocalcific. The enamel found in this group exhibits normal thickness, but it is soft. Often the enamel is completely abraded away soon after eruption. This results in a tooth with a crown that ranges in appearance from a dull opaque white to a dark brown. In addition, these teeth are usually rough and pitted.

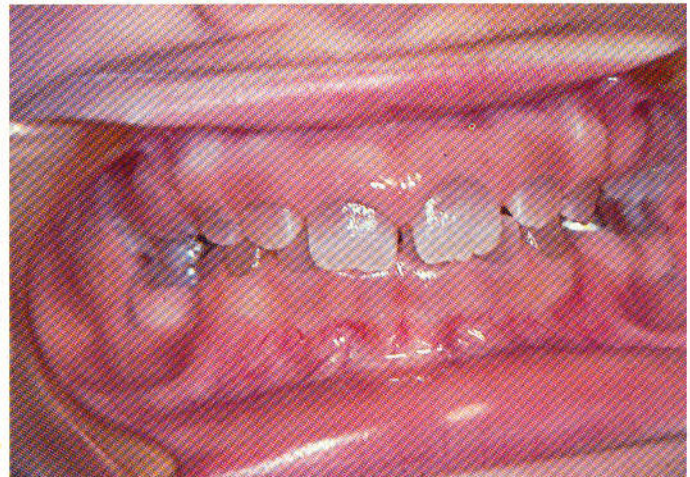


Fig. 3-3

Hypoplastic. Enamel found in this group is usually quite thin, often to the point of eliminating interproximal contacts. They usually have a smooth, hard, yellow appearance, although some pitting is found on occasion. (From Ishikawa's *Color Atlas of Oral Pathology*. Ishikawa G, Waldron C. St. Louis: Ishiyaku Euro-America, 1987.)

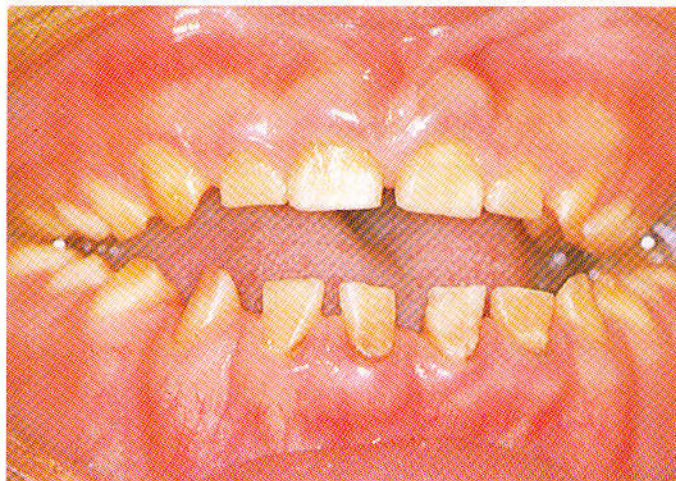


Fig. 3-4

Treatment: *If the amelogenesis imperfecta is of a variety which exhibits sufficient enamel thickness, the teeth should be aggressively treated with topical fluoride. Following this treatment, the enamel may be found to be suitable for bonding. The more common, as well as predictable, treatment is to provide full prosthetic coverage for the affected teeth. Those teeth which exhibit either insufficient, weak, or abraded enamel must be treated by full prosthetic coverage. Any vital bleaching technique is contraindicated.*

Dentinogenesis Imperfecta. This inherited trait is the most prevalent hereditary dys- trophy affecting the structure of teeth. It usually affects the primary dentition more seriously than the permanent dentition.⁷ The clinical crowns appear reddish-brown to gray opalescent. Often the enamel is friable, and breaks off soon after eruption. The exposed softened dentin then rapidly abrades away.

Treatment: *Due to the thin or even non-existent enamel, there are no other options than to treat this condition with full prosthetic coverage. Vital bleaching is contraindicated.*

Endemic Fluorosis. This condition is an enamel alteration caused by the excessive intake of fluoride during odontogenesis. The appearance of fluorosed teeth ranges from slight wisps and flecks of opaque white to mottled or pitted darkened sections next to normal looking areas.⁸ It was noticed and described as early as 1916, although the causative agent was not discovered until 1931. Black thought that the stain was caused by the replacement of the normal cementing substance between enamel rods by "brownin". We now understand that dental fluorosis is a form of enamel hypoplasia.⁹ Currently, it is believed that the hypoplasia is caused by metabolic alteration of the ameloblast during enamel formation.

Dental fluorosis is often found in communities in which the fluoride content of the drinking water exceeds one part per million.¹⁰ The degree of severity of the staining is directly proportional to the amount of fluoride absorbed, and the teeth can be affected from the second trimester *in utero* through age nine.¹¹

On the left are maxillary incisors with very mild mottled enamel. On the right are teeth displaying corroded and stained surfaces. (From Ishikawa's *Color Atlas of Oral Pathology*. Ishikawa G, Waldron C. St. Louis: Ishiyaku Euro-America, 1987.)

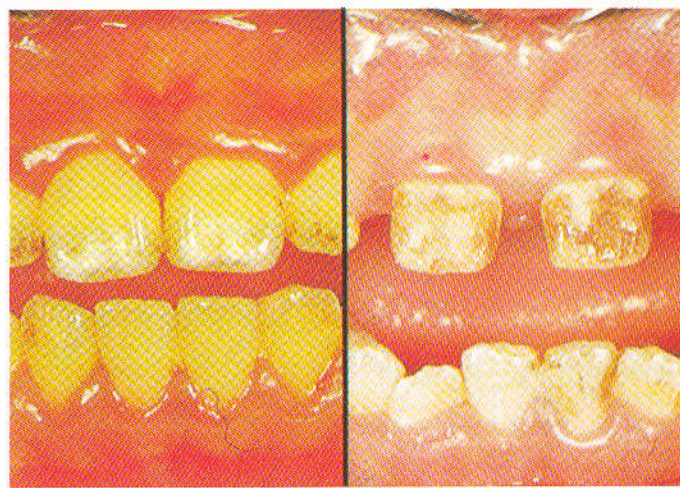


Fig. 3-5

Treatment: Areas of the tooth darkened by endemic fluorosis respond to vital tooth whitening. If the stains are set deep into the tooth and are very opaque, however, only limited success should be expected. In these cases, the proper technique is to perform tooth whitening procedures followed by bonded porcelain or composite. Those teeth which exhibit white areas obviously cannot be darkened by tooth whitening procedures. If the areas are superficial, they can be treated by enamel abrasion. If the tooth exhibits both dark and opaque white areas, the treatment of choice is to abrade those areas where the stain appears superficial, and then to institute tooth whitening procedures. Finally, if the improvement is not sufficient, conservative bonding procedures can be used.

Erythroblastosis Fetalis. This is a blood disorder of the neonate due to Rh incompatibility of the fetal and maternal blood supplies. It is characterized by agglutination and hemolysis of the erythrocytes, resulting in free blood pigments. These pigments sometimes discolor all the teeth which are in formation at the time. The affected teeth can range in color from brown to greenish-blue.¹² This condition is usually self treating, and the staining resolves as the child matures.

Discolored deciduous teeth in a six-year-old child with a history of erythroblastosis fetalis. (From Ishikawa's *Color Atlas of Oral Pathology*. Ishikawa G, Waldron C. St. Louis: Ishiyaku Euro-America, 1987.)

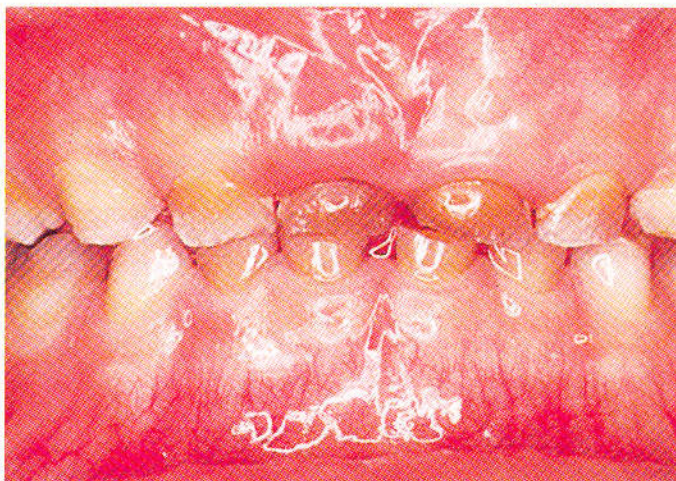


Fig. 3-6

Treatment: *Usually none is necessary.*

Porphyria. This is a disorder of porphyrin metabolism which results in increased formation and excretion of porphyrins. It is a rare condition which is usually genetically transmitted, although it may develop later in life. The disease exhibits neurological, psychological, and gastrointestinal symptoms. In addition, the hematoporphyrin pigment creates a characteristic reddish-brown discoloration of the teeth sometimes known as "erythrodontia".^{13,14} The dental effects are more commonly seen in the primary dentition than the permanent dentition. The coloration is dispersed throughout the enamel, dentin, and cementum, and fluoresces red under ultraviolet light.

Treatment: *Tooth whitening, sometimes in conjunction with bonding.*

Sickle Cell Anemia and Thalassemia. These are both inherited blood dyscrasias which on occasion result in tooth discolorations similar to those of erythroblastosis fetalis. Unfortunately, unlike erythroblastosis fetalis, the discolorations from these two dyscrasias are more severe and do not improve with time.

Treatment: *Tooth whitening, with the addition of bonding procedures for the more intractable cases.*

Tetracycline Staining. The potential for tetracycline to cause discoloration of the dentition has been well documented and explored since first reported by Schwashman and

Schuster in 1956.¹⁵ Since tetracycline can cross the placental barrier, tetracycline affects both the deciduous and permanent dentitions, making the teeth vulnerable throughout odontogenesis. Even as short an exposure as three days can cause discoloration of the teeth any time from four months *in utero* through age nine.¹⁶

Much study has gone into the mechanism of staining caused by tetracyclines, and it now seems clear that tetracycline binds to the calcium in the tooth, forming a tetracycline-calcium-phosphate complex. It is found throughout the tooth, but by far the greatest concentration is in the dentin near the dentino-enamel junction. Both the quality and the severity of the discoloration are directly related to the specific tetracycline ingested as well as the dose.

Some of the early investigations revealed that the teeth affected by tetracycline first exhibit a yellow color and display a bright yellow fluorescence far different from the blue fluorescence of normal (healthy) teeth.¹⁷ The yellow fluorescence and yellow color are visible in both the dentin and the enamel of the affected teeth, although the greatest concentration is found in the dentin near the dentino-enamel margin.

Tetracycline-induced discoloration can be seen on the incisal edges of the permanent anterior teeth of this 14-year-old. Massive doses of tetracycline were administered when this individual was an infant. (From Ishikawa's *Color Atlas of Oral Pathology*. Ishikawa G, Waldron C. St. Louis: Ishiyaku EuroAmerica, 1987.)

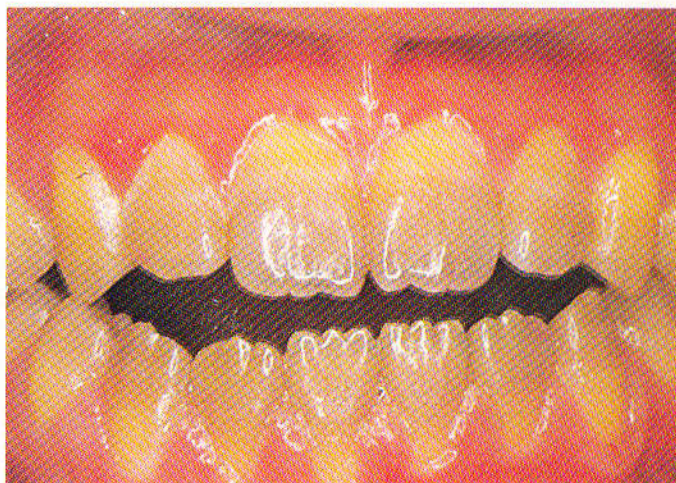


Fig. 3-7

Interestingly, the color of the affected teeth gradually changes over a period of time ranging from months to years. This color change is most pronounced in those teeth which are most exposed to light, the facial surfaces of the anterior teeth.¹⁸

Wallman and Hilton clearly demonstrated the role of light in this process in 1962, by splitting a tetracycline-stained tooth lengthwise and exposing only one half to light. The half which was exposed to light underwent a color change, becoming brown, while the half which was unexposed to the light remained yellow.¹⁹ It is for this reason that many researchers feel that the use of heat and light bleaching systems in the treatment of tetracycline stained teeth may be contraindicated.

In 1983, Davies, et al., produced a study which gave strong support to the belief that the tetracycline was transformed into 4a,12 a-anhydro-4-oxo-4-dedimethylaminotetracycline (AODTC).²⁰

The clinical appearance of tetracycline-stained teeth ranges from light yellow to dark gray bands. Usually the darker shades are confined to the gingival one-third of the teeth, but the lighter, hay-colored shades will often be located exclusively in the incisal one-third.

Treatment: *Standard tooth whitening usually results in an improvement, although it is often an incomplete solution to the problem. The differentiation between the light and dark areas of the tooth is usually diminished after tooth whitening. On some teeth, selective etching of the enamel of the darker areas prior to whitening may be a further help. Bonding is usually necessary in the darker cases for perfection, although the degree of improvement from vital tooth whitening alone can be profound. Since the differentiation between the darker and lighter areas becomes less distinct, many patients are content to defer any bonding. Those cases exhibiting a yellow or brown discoloration generally whiten more completely than those with a gray or blue hue.*

Post-Eruptively Caused Discolorations

Age. Several non-pathologic conditions which are related to the process of aging work to gradually discolor the teeth over time. The natural process of gradual pulp withdrawal with the formation of secondary dentin causes the development of a yellowish-brown color.²²

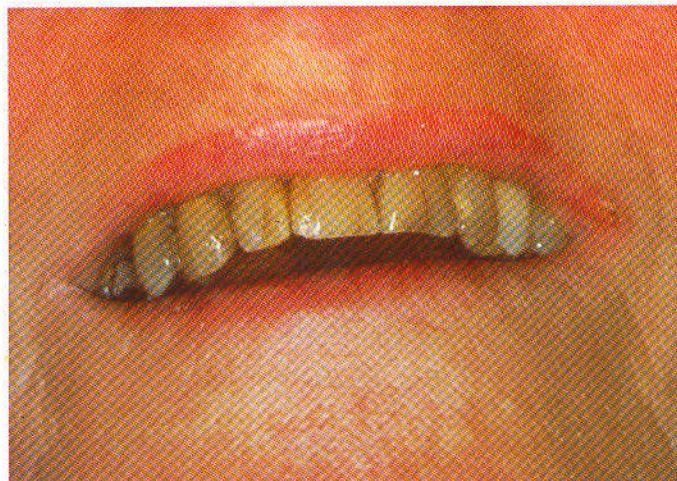


Fig. 3-8

Treatment: *This is perhaps the strongest indication for tooth whitening. The results are the most rapid, and predictable. Standard vital tooth whitening should be used for these cases.*

Dental Metals. The most ubiquitous source of staining from dental metals is the leeching of corrosion products from amalgams. Another source of similar staining is threaded stainless steel pins, or gold-plated retentive pins. These stains can be extremely dark and pose a significant challenge for any whitening efforts.²²

Tooth discolored from dental alloy.



Fig. 3-9

Tooth stained from pins.



Fig. 3-10

Treatment: *Where possible, the dental metals can be replaced by composite or porcelain restorations. In cases of deep dark staining, the prognosis is not very good. Usually some type of bonding is necessary for perfection. If the staining is from retentive pins and tooth whitening is to be successful, the pins must be removed.*

Foods and Beverages. Some of the best known staining agents of teeth are smoking, tea, coffee, and chewing tobacco. As would be expected, the degree and quality of the staining is directly related to the type, frequency, and length, and quality of exposure to the staining agents.

Treatment: *These stains are one of the areas where vital tooth whitening excels. Standard technique can usually be expected to produce rapid, dramatic results.*

Idiopathic Pulpal Recession. A tooth may, on occasion, display idiopathic pulpal recession. Such teeth remain vital, but usually display a yellow to brown darkening. The appearance is often one of a non-vital tooth, but the tooth's actual condition can be differentiated on the basis of vitality testing.



Fig. 3-11

Such teeth will usually show greatly diminished pulp chamber size radiographically.



Fig. 3-12

Treatment: Standard tooth whitening procedures should be instituted if the desired result is an overall whitening of all the teeth. This will be effective in removing the discoloration of the tooth with the idiopathic pulpal recession, and will usually result in a whitening effect on all the neighboring teeth as well. The discolored tooth will whiten more rapidly than the other teeth, so the result will be a blending and better matching of shades. The patient will eliminate the problem of a single, non-matching tooth, and will lighten all the other teeth in the process. On occasion (such as in the presence of multiple porcelain crowns which match the current dominant shade) this may not be desirable. Under those circumstances, the older heat/peroxide bleaching techniques may sometimes be effectively used. An alternative would be to utilize bonding to mask the discoloration.

Non-Alloy Dental Materials. Many of the materials which we use routinely have the potential for causing discoloration of teeth. Eugenol, formocresol, root canal sealers, and others can create a veritable rainbow of effects in tooth coloring.²³

Treatment: *The treatment is the same as for the dental alloy material staining. If the tooth has vitality, standard vital tooth whitening is usually effective. The difficulty most commonly found with this category of staining is that it can be extremely localized. Thus, the procedure selected should be dictated by the same factors as in staining from idiopathic pulpal recession. If the tooth is non-vital, standard non-vital bleaching should be utilized. Sometimes the stains are so dark and resistant to whitening that supplemental bonding is indicated.*

Traumatic injury. Trauma to the tooth occasionally results in internal hemorrhage. The ensuing diffusion of bilirubin into the dentinal tubules creates a pink discoloration which usually is followed by the development of a diffuse reddish-brown stain.²⁴ (From Ishikawa's *Color Atlas of Oral Pathology*. Ishikawa G, Waldron C. St. Louis: Ishiyaku Euro-America, 1987.)



Fig. 3-13

If the pulp is able to avoid necrotic degeneration, the natural color of the crown returns within a few weeks after the injury. If the pulp degenerates, the natural color will not return, and the discoloration can darken. In some cases, a slowly growing pink spot on the enamel surface will appear, indicating ongoing internal resorption.

Treatment: *No treatment should be instituted until it is felt that the tooth has fully recovered from the trauma. Sometimes the natural color will return without intervention. In those cases with residual discoloration, the tooth should be tested for vitality and radiographed. If the tooth is vital, and there is no evidence of internal or external resorption, tooth whitening can be instituted. If the tooth is non-vital, endodontic therapy should be initiated, followed by non-vital bleaching. If the tooth is vital, but exhibits internal resorption, endodontic therapy should be instituted, and non-vital bleaching begun.*

Darkened non-vital tooth.



Fig. 3-14

TOOTH STAINS

Extrinsic Stains

Tobacco
Foods and Beverages
Medications

Intrinsic Stains

Pre-eruptively Caused Discolorations

Alkaptonuria
Amelogenesis Imperfecta
Dentinogenesis Imperfecta
Endemic Fluorosis
Erythroblastosis Fetalis
Porphyria
Sickle Cell Anemia
Thalassemia
Tetracycline Staining

Post-Eruptively Caused Discolorations

Age
Dental Metals
Foods, Beverages, and Habits Such As
Smoking
Idiopathic Pulpal Recession
Non-alloy Dental Materials
Traumatic Injury

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Chapter 4

Diagnosis and Treatment Planning

In the treatment of tooth discolorations, the accurate diagnosis of the patient's problem(s) must be the dentist's first goal. Without a thorough understanding of the factors affecting the patient's dentition, any treatment would merely be conjectural.

While some of the steps described in the following pages may seem tedious and unnecessary, they provide the practitioner with an exhaustive analysis of the dental discoloration, and this analysis will invariably prove to be of benefit. The patient will receive a well-thought-out treatment sequence that he can comprehend and in which he can enthusiastically participate; and the dentist will be fully aware of both the possibilities and the limitations of the upcoming treatment.

Complete Medical History

The emphasis here must be on the word "complete". Even though tooth whitening is inherently a cosmetic procedure, the dentist is as fully responsible for the wellness of the patient as with any other dental treatment. The standard medical questionnaire used by most dental offices should suffice, however, some additional questions relating to materials and habits that have a direct effect on tooth coloration may need to be added to the basic list.



Fig. 4-1

Pregnancy. While there has been no indication that tooth whitening during pregnancy is contraindicated, conventional wisdom leads one to avoid any elective procedure until its absolute safety under these circumstances is documented.

Tetracycline exposure. It will be helpful for the dentist to know whether tetracycline has had any part in the discoloration of the teeth. This knowledge may change both the approach to, and prognosis of, treatment.

It is well established that the ingestion of tetracyclines at times of amelogenesis and dentinogenesis will affect the coloration of the teeth being formed at that particular time. The antibiotic, taken by an expectant mother in the latter half of pregnancy, will result in the staining of the deciduous teeth and the incisal regions of the permanent anteriors. Any child who is given tetracycline during the years of tooth formation will develop stained permanent dentition.

Fluoridation. In certain parts of the world, the drinking water fluoride concentration exceeds 1ppm. Where the natural concentration exceeds 4ppm, most of the children are likely to develop significant discolorations.

In much of North America, the drinking water is fluoridated, and if not, children are generally given a fluoride supplement. This has brought about an improvement in children's dental health, but has also been the cause of increased minor fluorosis. Since the fluoride additives taste good, children might sneak an extra tablet or two. They may also regularly swallow the pleasant tasting fluoride toothpastes that are on the market today. In either case, a chronic small excess of fluoride can create chalky areas on the developing tooth which will be noticed upon eruption.

Trauma. The discoloration induced by traumatic injury is often limited to a single tooth. Even more of a problem is the tendency of traumatized teeth to continue becoming darker (or yellower) long after they have sustained an injury, despite the dentist's best efforts to stabilize and blend the coloration with the rest of the dentition.

Habits. Certain forms of repetitive behavior may influence the present coloration of the teeth, and the likelihood that an improved appearance can be maintained. The dentist must know if the patient is an active drinker of tea, coffee, or colas. These beverages cause a readily correctable form of staining, but they may compromise the maintenance of a whitened smile. Smoking (cigarettes, pipes) and chewing tobacco are much more invasive. The stains follow the microfissures of the tooth structure internally, and may be very difficult to eliminate.

Sensitivity. Any known sensitivity to hydrogen peroxide, polyresin, acrylic, or any of the other materials used for tooth whitening will certainly alter the course of treatment.

Pretreatment Picture

The dentist should take a picture before commencing any treatment; in fact, the photographic record should be made even prior to removing the surface plaque from the teeth. This picture is then called the *baseline*. It represents the actual condition of the patient as he presented in the office. Any improvement from this point onward is due to the intervention of the dentist, directly or indirectly.



Fig. 4-2

General Oral Examination

It is important to perform the initial general oral examination before prophylaxis. There are certain conditions that warrant attention before even routine treatment is embarked upon. The general oral exam involves an inspection of the soft tissues, the hard tissues, and a radiographic analysis. After all, the dentist is undertaking the care of the patient, not merely serving as an agent who will whiten the dentition.

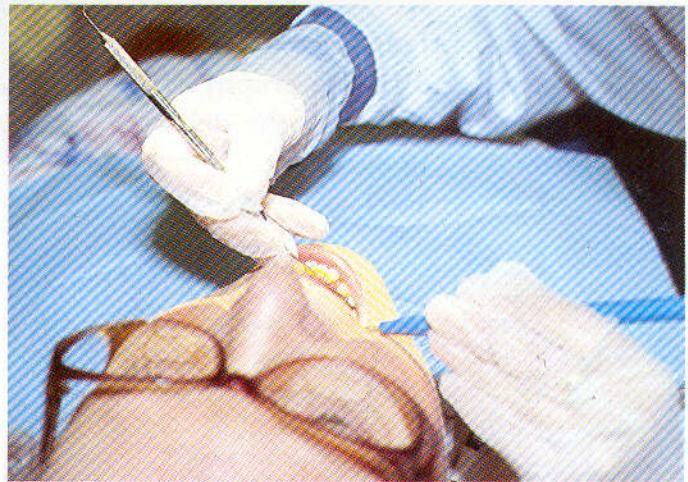


Fig. 4-3

It is all too easy to propose a whitening procedure, have it accepted by the patient, and to then begin treatment without adequate attention to other oral conditions. Ultimately, the responsibility for complete dental care rests with the practitioner; he should at all times be aware of his responsibility and potential liability.

The dental IQ of the patient can easily be determined at this time. This observation may provide clues to the patient's future cooperation during the treatment phase, and to the likely retention of the results that have been achieved through whitening. This is a very good time to instill awareness of oral hygiene procedures and their importance, since the patient is receptive and motivated to cooperate. Also, since the patient is acutely conscious of one of the benefits of dental health (clean, white teeth), they can usually comprehend and accept any other required restorative and/or cosmetic services.

Prophylaxis

Routine scaling and prophylaxis will eliminate plaque, calculus, and extrinsic staining. This step by itself may achieve a significant degree of tooth whitening, and provide enough positive reinforcement to the patient so that he will more readily undertake a whitening treatment.



Fig. 4-4

A standard prophylaxis employing a bristle brush and coarse prophylaxis paste will remove not only the debris, but approximately 10 microns of the outer layer of the enamel. (A rubber cup removes a bit less.) This can be particularly useful where there is superficial opaque intrinsic staining (such as some types of endemic fluorosis).



Fig. 4-5

Detailed Examination and Diagnosis

Once extrinsic staining has been eliminated, the patient and the dentition are reevaluated. The dentist, now familiar with the patient's dental and medical histories, is in a much better position to evaluate the cause of the dental discoloration. Once the etiology is established, the dentist can determine the likely prognosis of his choice of treatment, its duration, and any difficulties that may arise in its implementation.



Fig. 4-6

The use of transillumination to evaluate the internal morphology of the tooth is particularly helpful in determining the severity of the case. As the bright light passes through the different layers of the enamel and dentin, it provides information on the opacity and the depth of any discoloration or hypocalcification. The light may also reveal incipient caries missed by other diagnostic means.

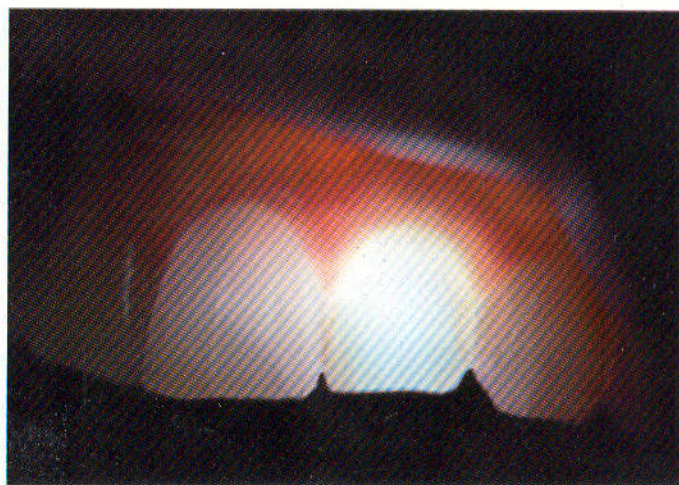


Fig. 4-7

Treatment Plan

The nature of the problem is briefly described to the patient. A detailed discussion of the proposed treatment plan, the prognosis, benefits, potential problems, and the length of treatment will serve to inform the patient adequately enough to decide on whether he is willing to proceed.

The other important item requiring clear communication is the cost to the patient. If there is a mutual understanding (and perhaps a written confirmation statement) of the fee involved and the mode of payment, it is less likely that any misunderstanding will crop up at some future date. Once the patient, supplied with all the facts, decides to commence treatment, the dentist should proceed at once to take impressions for the custom tray.



Fig. 4-8

1. Take a complete medical history
2. Take a pretreatment picture
3. Do a general oral examination
4. Perform a prophylaxis
5. Reexamine and diagnose
6. Establish the treatment plan

Chapter 5

Materials

There are a several somewhat similar materials which can be used for the home tooth whitening procedure. While they may superficially appear to be equivalent, the authors caution that differences do exist between the various products. Differences exist, for instance in pH, viscosity, concentration, and even composition. In addition, there are possible interactions between the whitening agent and the tray material itself.

Doubtless, every material will have its proponents and detractors. In the end, the choice of materials is a personal decision. In order to make a rational decision between the various brands, the dentist should insist on seeing the safety and efficacy research conducted on the particular brand under consideration. In addition, the dentist should be concerned about the degree of support available from the product manufacturer. Certainly these issues should be addressed prior to use of any product of this nature.

For reasons of continuity, the authors have chosen to demonstrate one particular system in detail, although the steps involved are similar for all brands. For illustrative purposes we have chosen Omnii White & Brite.

Whitening Liquid. The whitening liquid in the vital tooth whitening technique is a perhydrol urea (carbamyl peroxide) solution. This is available in varying concentrations, viscosity, and acidity. For example, Omnii White & Brite consists of pure 11% perhydrol urea in a proprietary food additive base. No carbamide or hydrogen peroxide is added to this solution. The solution also contains glycerine which has previously been heated to 180° C. The entire solution is stabilized to a shelf life of two years with a neutral pH of 6.8-7.0.

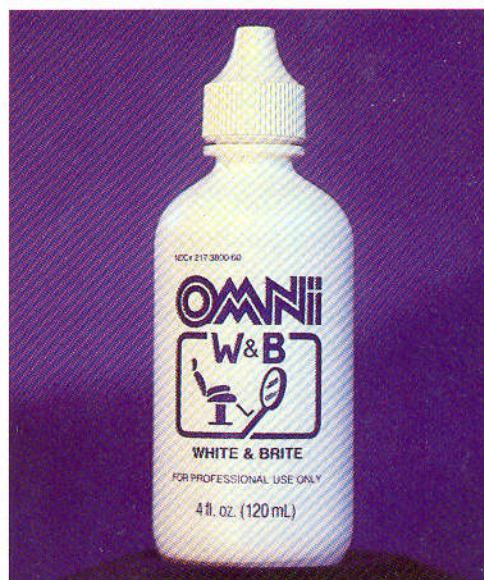


Fig. 5-1

The active component in the perhydrol urea is hydrogen peroxide. Chemically, 11% perhydrol urea is equivalent in activity to approximately 3% hydrogen peroxide. Hydrogen peroxide has traditionally been used intraorally as an antimicrobial solution with both hemostatic and detergent attributes. It has been shown to be non-toxic, non-allergenic, and generally palliative to the tissues.

It achieves these actions by its breakdown into water and oxygen. The nascent oxygen released is very active and causes the bleaching effect that is so well known. Because the solution is more stable at lowered temperatures, it is best stored in refrigerated conditions where convenient.

Stannous Flouride Solution.

Many tooth whitening systems utilize a stannous flouride solution as part of the regimen. Others do not. The inclusion of the stannous flouride is the result of experience with the system. In a small percentage of the cases, some transient tooth sensitivity can occur. This can be prevented or quickly alleviated through the use of fluoride solution. In addition to the desensitizing effect. This solution has a rehydrating and palliative effect on the gingivia.



Fig. 5-2

The Perio Med solution used in the Omni System is a stabilized 0.63% stannous fluoride solution in a non-active lipolized base. It becomes activated when mixed with tap water. It is normally diluted 7 parts water to 1 part Perio Med, resulting in a 0.08% activated stannous fluoride solution. In this concentration, the solution is somewhat bacteriocidal. The ionized fluoride is quickly adsorbed to the surface of the tissues. This not only results in the replacement of the hydroxyapatite portion of the tooth structure with the stronger fluorapatite, but decreases hypersensitivity as well.

Tray Material. The tray material most commonly used for home bleaching consists of 0.02 inch thick flexible acrylic material. The Omnii System uses a polyresin material which is inert in contact with the peroxide solution. Early trials with acrylic tray materials have indicated a possibility of release of potentially damaging free radicals from the interaction of the whitening agents and acrylic.

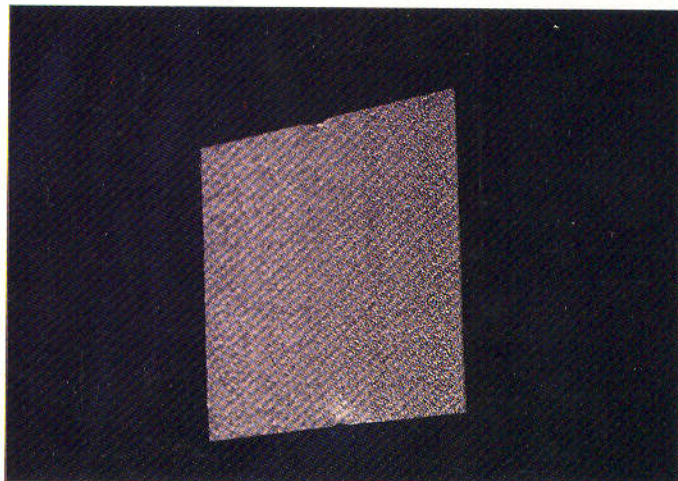


Fig. 5-3

The polyresin material is provided in sheets sized to fit a vacuformer, and often has one shiny side and one dull side. If a foam lining (accelerator) is being utilized, the dull side of the sheet is the surface which bonds to the absorbent sponge lining. This polyresin material also can withstand autoclave sterilization, a procedure that may be required in the future by OSHA for all intraoral prosthesis delivered by the dentist.

Accelerator. When used, the accelerator is a porous, sponge-like layer of inert plastic material which bonds to the tray material. This material produces a more intimate seal of the tray to the patient's teeth, while at the same time creating a fit which is more comfortable. In addition, the tray liner adsorbs some of the perhydrol solution, thus keeping the tooth in contact with a larger pool of the liquid than in trays made without the liner. The use of this liner can reduce (by half) the time needed for adequate whitening.

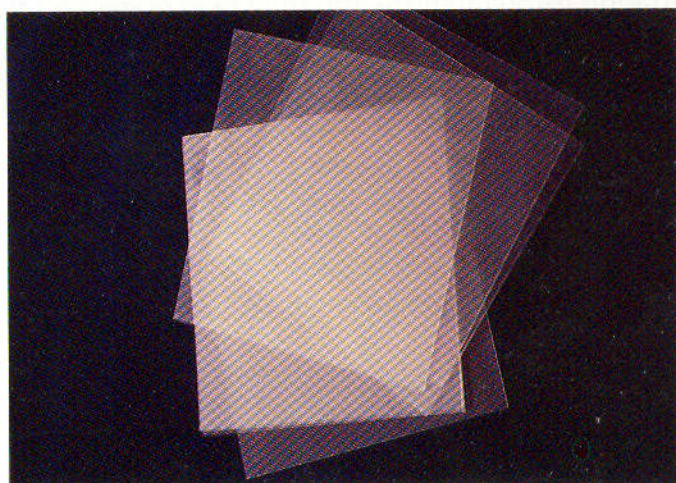


Fig. 5-4

Tooth Structure. It may seem odd to include tooth structure as one of the materials involved in the tooth whitening procedure, but understanding the whitening process absolutely requires an understanding of some of the characteristics of the tooth. Although enamel is the most dense structure in the human body, it still contains approximately 0.1% to 0.2% space by volume.¹ Although this means that the enamel is only minutely porous, it is porous none the less. These enamel "pores" become enlarged by the application of weak acids. A 60 second application of 30% orthophosphoric acid not only results in a loss of 10 microns of surface topography, but about a 20 micron depth of histological change. This change allows easier access for whitening agents to the interconnecting pathways between the enamel pores (Bergman and Hardwick hypothesized that they are the pathways used for transport of ions and tissue fluid).^{2,3}

Lampros et al., clearly demonstrated that this permeability can be significant.⁴ They found that iodide ions readily pass through the coronal walls of the tooth. In 1981, Seale et al., reported that dog tooth pulps underwent severe destructive changes when the enamel was treated with 35% hydrogen peroxide. They concluded that "the porosity of the enamel to certain substances appears to have once again been substantiated by the marked response of the pulps of teeth receiving only hydrogen peroxide".⁵

This should not have been a surprise, since in 1947 Atkinson et al., not only documented the permeability of enamel, but went on to discover that the degree of permeability in persons less than twenty years old is nearly double that of older persons. They further concluded that the tooth remains permeable throughout life.⁶ Three years later, Wainright and Lemonine found that the penetration of intact enamel occurs even without the presence of lamella or cracks.⁷

This finding was corroborated by Bowles in 1987, who found that even 1% solutions of hydrogen peroxide quickly traveled through the dental tissues all the way to the pulp chamber.⁸ Thus any notion of enamel as a dense impenetrable barrier must be updated.

If the enamel is permeable, it would certainly be expected that dentin and cementum would be porous as well. Research has shown this to be true. Avny et al., demonstrated penetration throughout the full thickness of dentin by parachlorophenol in various concentrations.⁹ This finding was corroborated and further augmented by Taylor et al., who found that the parachlorophenol not only penetrated through the dentin, but diffused through the full thickness of the cementum layer as well.¹⁰ It is not surprising therefore, that the whitening effect of perhydrol urea is not confined to the outermost few microns of the enamel. The pathways for facilitating its whitening effect throughout the teeth have been well elucidated.

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Chapter 6

Clinical Technique

The tooth whitening procedure actually begins with patient evaluation, since a thorough medical and dental history should be performed before initiating any therapy. In addition to the usual health history, however, information should be taken regarding the causes of the patient's present condition, as well as the patient's hopes and expectations of the treatment.

Photographs should be taken prior to any treatment, including even a prophylaxis. This set of photographs should include at least one photograph with a standard shade guide tab in the field for color reference.

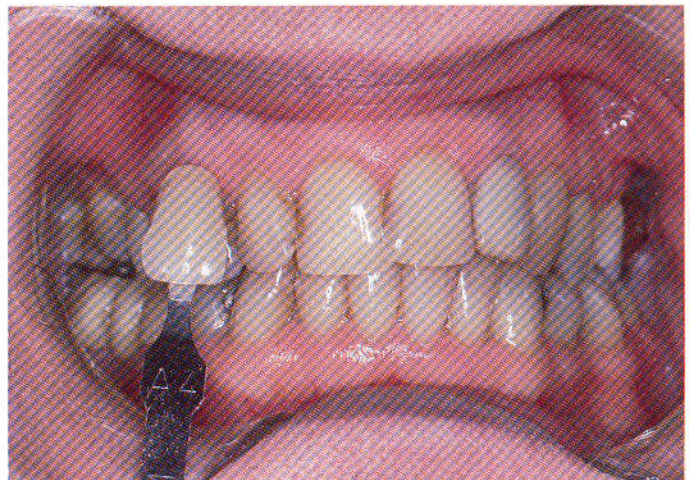


Fig. 6-1

If some other method of color assay is available, such as a full spectrum colorimeter, then it can be used in place of the standard method of comparison with shade tabs. A colorimeter being developed by Dr. Francois Duret is shown here.



Fig. 6-2

Notations should be made in the patient's chart describing the shade and condition of the teeth prior to any treatment. We have found it best to allow the patient to participate in the determination of their present shade.



Fig. 6-3

Besides the normal clinical evaluation, the dentist should carefully inspect all teeth which will come into contact with the whitening liquid. Of particular interest would be the discovery of any major cracks in the teeth, ...



Fig. 6-4

or decay or leakage under existing fillings.



Fig. 6-5

Transillumination can be of great help in detecting these problems. Leaky fillings or frank caries will need to be restored prior to initiation of the whitening process. The patient should be informed that these and all other existing tooth-colored fillings will remain largely unchanged, even though the teeth themselves can be expected to whiten. In fact, the degree of whitening can often be gauged by the increasing contrast between the existing composite fillings and the surrounding tooth structure.



Fig. 6-6

Naturally, the patient should be informed prior to the whitening process that any visible anterior fillings or crowns will probably need to be replaced at the end of the whitening procedure.



Fig. 6-7

The dentist should also make note of any cervical abrasion, exposed root structure, or severely diminished enamel thickness.



Fig. 6-8

Following the establishment of these baseline conditions, it is usually necessary to perform a thorough prophylaxis of the teeth, which is then followed by a re-examination. At this point it is important, although not critical, to ascertain the type of discoloration involved in the teeth. This analysis will help in predicting the degree of lightening to be expected, along with the amount of time needed.

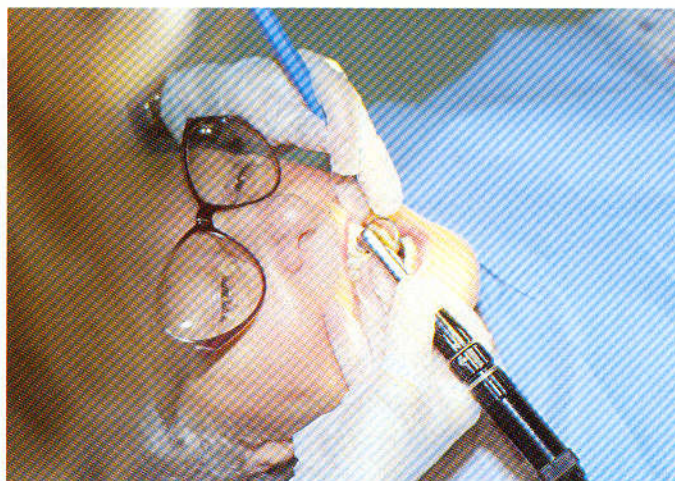


Fig. 6-9

Careful discussions utilizing good listening skills should be employed to gauge the patient's level of expectations from the procedure. Once the type and severity of the discoloration has been diagnosed, the patient should have their expectations aligned with reality.



Fig. 6-10

Often the discussions concerning the treatment plan can be more meaningful if the patient is shown photographs of the type of results which have been achieved in similar situations with other patients. If this is done, however, the patient needs to be made aware that every tooth is different and the examples simply cannot constitute a guarantee of similar results with their teeth.

They should also be told exactly what to expect in terms of the treatment itself. They are naturally interested in knowing such things as whether there will be any discomfort, whether they will be able to talk while wearing the tray, and whether they can eat while wearing the tray. Prior to initiating any sort of treatment, all of these aspects should be discussed and financial arrangements made.

Once the patient has elected to have the whitening procedure performed, the dentist should fill in any large areas of cervical abrasion of the teeth to be whitened. If this is not done, there could be a slight risk of sensitivity during the whitening procedure. In addition, were

the tray to be made to closely adapt to the facial anatomy of teeth with cervical abrasion, the tray could not easily be placed and removed. Therefore these cervical restorations must be placed at this time even though they will probably need replacement after the tooth whitening procedures.

Even when all cervical abrasions are bonded over with resin, patients with exposed root structure or severely diminished enamel thickness should be told that they may have to limit the time of continuous exposure to the whitening liquid if they experience any sensitivity. Certainly during treatment they should avoid exposure to citrus fruits, apples, and other acid containing substances in order to avoid exacerbating their condition.

Prior to taking an alginate impression of the arch to be whitened, the dentist must also either place or replace any other restorations which will result in a change of contour. Any leaky fillings or minor caries can be left until after the impression.

After this preparation, the assistant should take an alginate impression of the arch which is to be whitened.

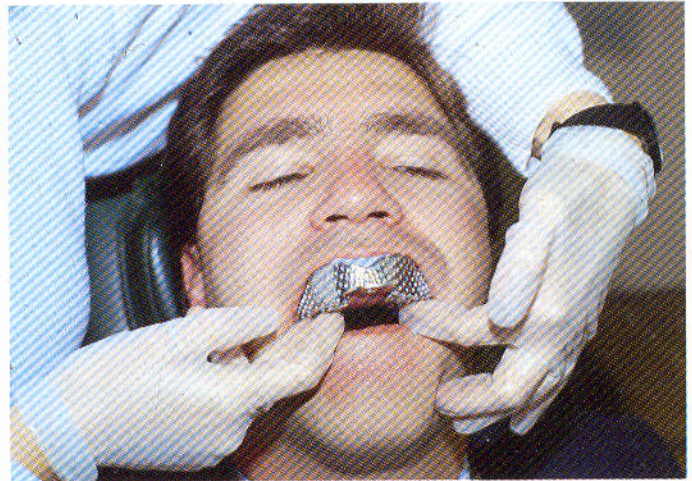


Fig. 6-11

The impression tray should fit comfortably in the mouth without scraping the facial borders of any of the teeth. It is not necessary, however, to get a good registration of the palatal region, nor of the buccal fold. Hence, a stock tray can usually be used without any modification of the borders.

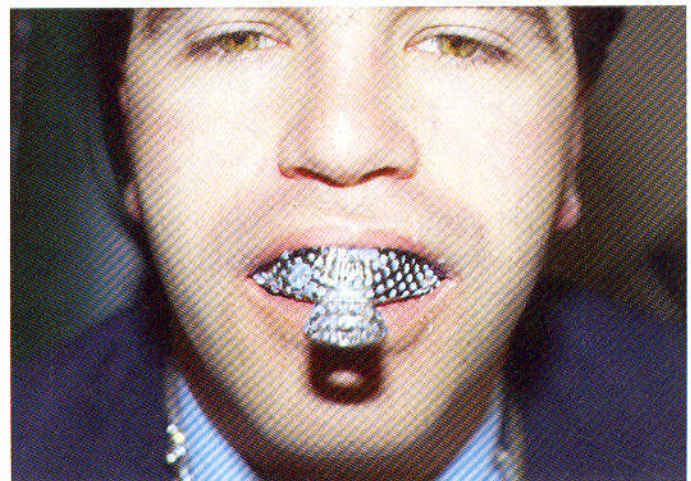


Fig. 6-12

If desired, soft periphery wax can be added to the border of the tray, for reasons of comfort rather than accuracy.

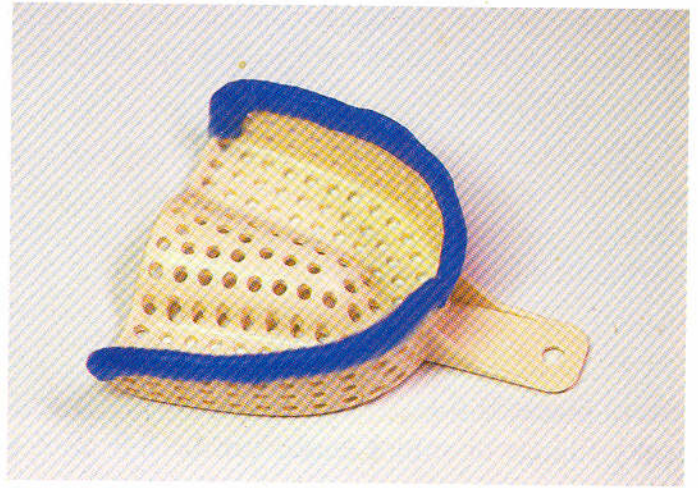


Fig. 6-13

Since the palatal region is not of any interest in this technique, it is often possible to utilize a stock mandibular tray for the maxillary arch. The resulting palateless impression makes it easy to pour a model which requires little trimming.

When using a mandibular tray for the maxillary arch, you may find that brands with a wide distance between the buccal and lingual flanges are most suitable. Since the lingual flange will prevent the tray from seating as deeply as a maxillary tray, the tray may need to be filled more fully with alginate than if it were being used for the mandible.



Fig. 6-14

The impression must include at least a part of the occlusal surface of every tooth in the arch. This is necessary because the final tray must cover at least a part of each tooth to prevent hyper-eruption. It is possible to fabricate a tray which only covers a few teeth, but such a tray should never be worn for periods greater than two hours.

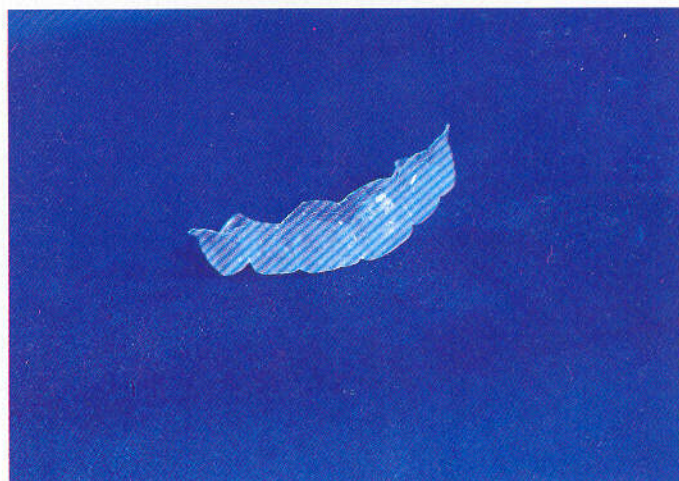


Fig. 6-15

Occasionally such a modified tray is used either for reasons of comfort, or to localize the whitening effect to a small block of teeth. The patient must be warned, however, that such a modified appliance can only be worn for short periods of time, and must alternate with either the full standard tray, or no tray at all. **Failure To Comply With This Instruction Can Result In Hyper-eruption Of The Teeth Which Are Not Included In The Tray.**

As soon as the impression is taken, an assistant can pour up the model. Alternatively, the impression can be sent out to the laboratory for tray fabrication.

It is possible to whiten both arches simultaneously, but it is generally not recommended. There are two major reasons for this. First, it is difficult for the patient to manage both trays at the same time, so compliance can become a major problem. Second, if only one arch is whitened at a time, the patient can use the remaining arch as a reference to gauge the treatment progress. It would be difficult to overestimate the value of patients being able to actually see the degree of whitening that is occurring in their own mouth. This leads to enthusiastic cooperation, and greater success for both the patient and dentist.

Prior to delivery of the whitening tray, the dentist should remove all remaining decay and replace all leaky fillings in the area chosen for tooth whitening. If the patient had much calculus, then some clinicians feel that they would not be a good candidate to begin the bleaching on the same day. It is currently believed that it would be best for those patients to first allow their gingiva to heal. In such cases the prophylaxis and scaling should be performed on one day, and the impression taken afterward. Then, after a suitable time for the reestablishment of good tissue tone, the patient can return to begin the whitening process.

When the patient receives the whitening tray, they need to be instructed in the use of the various materials. They should understand the importance of good hygiene during the whitening process. They should perform a scrupulous cleaning using a brush and an interdental cleaning device each morning. Toothpaste is not necessary, but thorough plaque removal is essential. Here a 0.04% stabilized stannous fluoride solution is being used in place of traditional toothpaste (Omni Med, Omnia International, St. Petersburg, Florida).

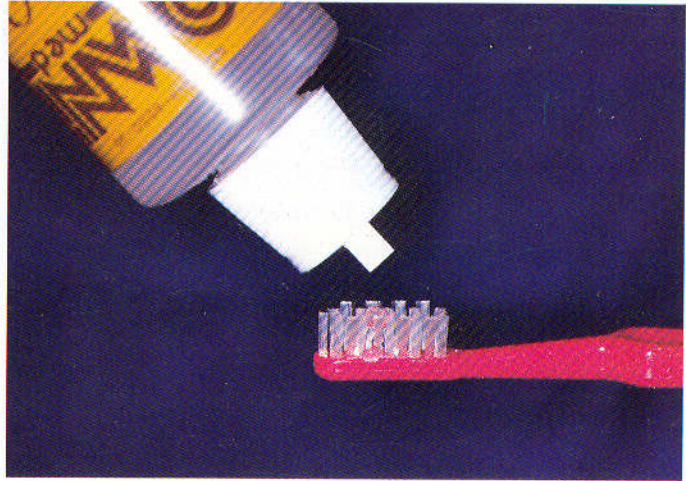


Fig. 6-16

Before placing the tray in the patient's mouth, it is checked on the model for contour and coverage.

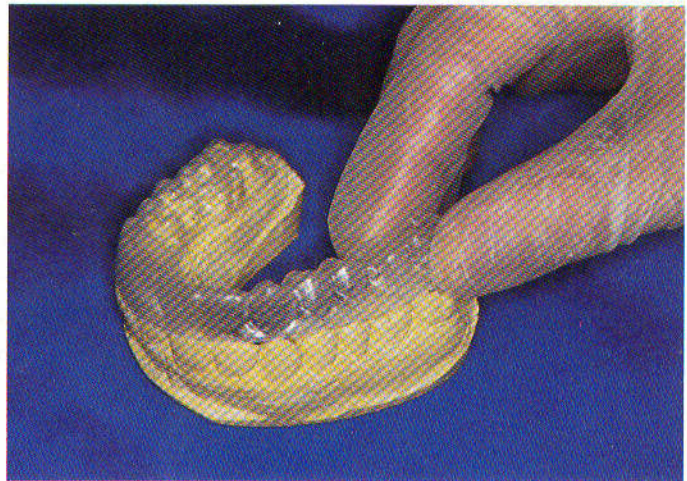


Fig. 6-17

The patient is shown how to insert the tray, and it is checked for fit. The tray must fit snugly, without any tissue blanching. It should allow the patient full movement of the lips and tongue without getting caught.

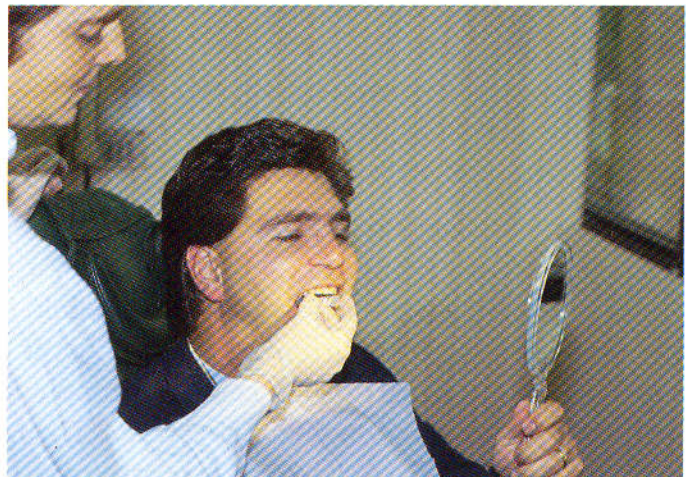


Fig. 6-18

If the tray fits too snugly, this can often be remedied by placing the tray under very warm tap water and flexing the tray.

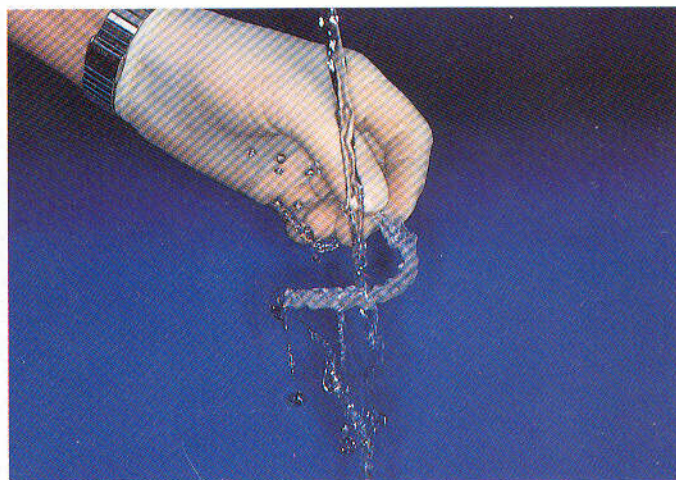


Fig. 6-19

The tray is then removed and the patient is shown how to place one or two drops of the whitening liquid into the tray along the facial wall of each tooth.

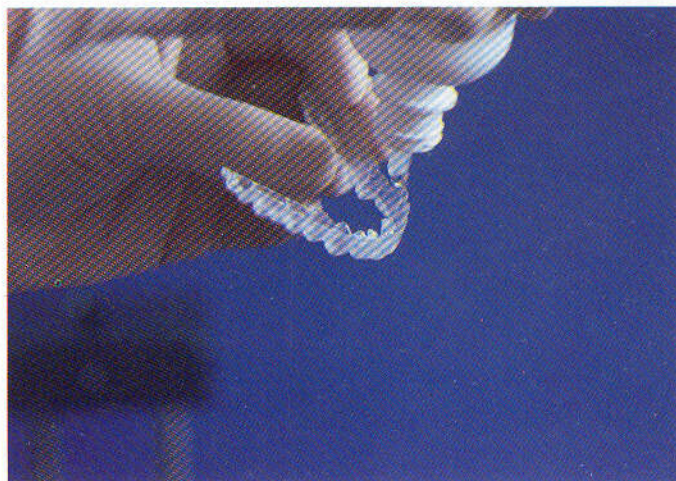


Fig. 6-20

The dentist or assistant may need to widen the orifice of the bottle to facilitate its flow.

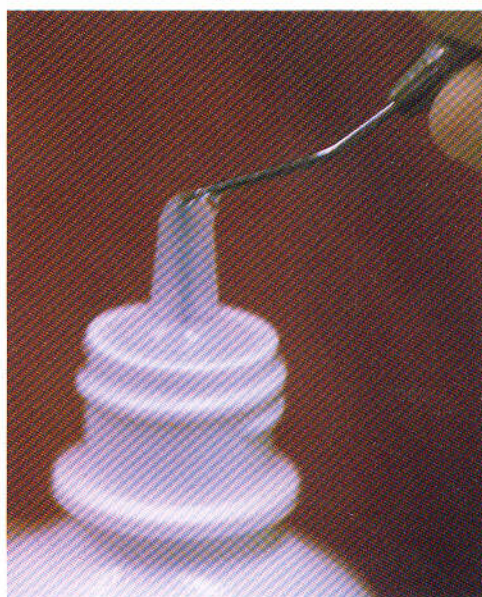


Fig. 6-21

Next, the patient places the tray with the whitening liquid into the mouth.

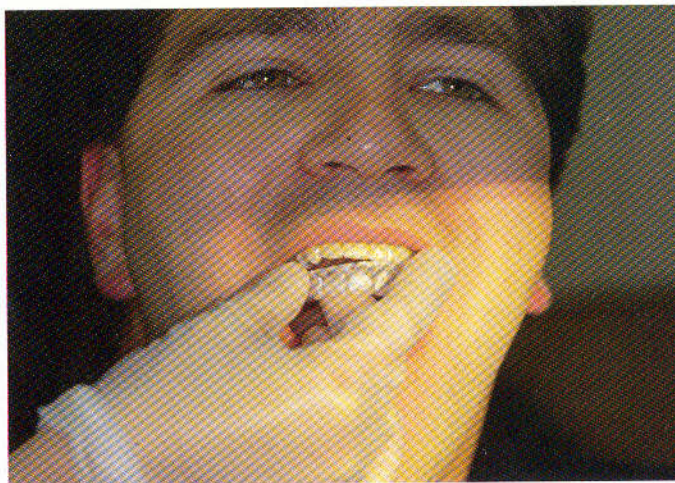


Fig. 6-22

Within a minute of placing the tray in the mouth, there will be a slight foaming action.



Fig. 6-23

The patient can then expectorate the slight excess of liquid.



Fig. 6-24

The patient is instructed to wear the tray for up to six hours a day, changing the solution every hour. Occasionally this time can be extended up to eighteen hours a day. The tray should not be worn while eating or drinking but may be worn during sleep. Patients must be cautioned to cut back on the time the tray is worn, or even discontinue wearing it for a day or two if they feel any tooth sensitivity. They should also be told that two things to avoid are biting down on the tray and sucking the liquid from it. Chewing on the tray can serve to squeeze out the liquid from the tray, and could potentially precipitate transient neuromuscular symptoms.

The patient is then shown the fluoride rinse. This liquid is diluted with one part fluoride to seven parts water, and used as a mouthrinse in the evening. It is most effective if it is held in the mouth for a minute before expectoration.



Fig. 6-25

The patient is given a written copy of the instructions and told to call the office if they have any questions or problems. These steps are the same regardless of which arch is being whitened. While intuitively it may seem that extra steps would be necessary for proper whitening of the lower arch, it is not so. Results such as these are common following the same regimen as for the upper arch. *Photo courtesy of Dr. Pat Anne Irene Doro.*



Fig. 6-26

If there has been a slight discrepancy in the model, it is possible that the patient may experience a slight discomfort somewhat like that of an orthodontic appliance. Usually this is limited to a single anterior tooth, and occurs only while wearing the tray.¹ This is often caused by a chip in the incisal edge on the model. It can be easily remedied by internally removing the offending spot on the tray with a round bur, or even fabricating a new whitening tray if necessary.

A second cause of discomfort is irritation of the gingiva or tongue caused by a sharp spot on the polyresin tray. This can be adjusted using a sharp pair of scissors or a green stone.



Fig. 6-27

On occasion, the patients may report a slight burning sensation of the throat or gingiva associated with the peroxide solution. They may even report a tingling or effervescent feeling on their gingiva when wearing the tray. This is easily remedied by leaving the tray out of the mouth for a period of time. Experience has shown that two to three days is usually more than sufficient.

In the early trials of the tooth whitening system, there were several reports of a transient hypersensitivity of the teeth exposed to the whitening solutions. This led to the development of the new tray design with minimal coverage of soft tissues, as well as the incorporation of the fluoride solutions into the daily regimen. With these two improvements, the incidence of sensitivity has nearly been eliminated. If such a hypersensitivity does develop, however, it can be remedied by avoiding use of the tray for a few days, while continuing to use the fluoride rinse.

An appointment should be set for approximately one week later to check on the progress of the whitening. If the whitening is not progressing by the time of the first progress check, the patient should have their teeth polished again, followed by a one minute application of acidulated fluorophosphate. Usually this is sufficient to speed up the initial phases of the whitening, and results should be seen in two to three days. In such cases, the patient should be told to be especially careful to avoid acidic foods during the whitening procedure.

Steps In The Tooth Whitening Process

1. Patient evaluation.
2. Clinical evaluation.
 - a. Assay the color of the teeth.
 - b. Ascertain type of discoloration.
3. Discussions with patient.
4. Protect areas of cervical abrasion, replace leaky fillings, and eliminate caries in areas of whitening.
5. Decide if impression can be taken immediately.

If So, Then:

6. Alginate impression.
7. Prophylaxis and scaling.
8. Delivery of system.

If Not, Then:

6. Prophylaxis and scaling.
7. Patient returns for impression.
8. Delivery of system.

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1. Darnell DH, and Moore WC. Vital tooth bleaching: the White and Brite technique. *Comp Cont Ed in Dent.* 1990;9(2):86-94.

Chapter 7

Treatment Evaluation

The scientific process is based upon both the demonstrability of effectiveness and the repeatability of results. The only rationale for attempting or continuing to use a treatment modality is the reasonable expectation of positive results. Therefore, the methods of treatment evaluation are actually part of the treatment process.

In esthetically motivated dentistry, the most accurate recording of the degree of success is standardized photography.¹ Despite this, in many cases the patient may be more interested in his own subjective, emotionally modulated, reaction to a particular treatment. As technology improves our mechanical analysis of color, dentistry will increasingly rely on techniques such as spectrophotometry to quantify both the initial conditions and the alteration achieved.²

The Concept of Baseline

The original coloration of the patient's teeth as first presented in the office is the baseline shade. This condition is determined and recorded prior to any treatment (including prophylaxis). The importance of timing for this determination cannot be overemphasized. A post-treatment photograph, for instance, can be secured at any time, but a baseline photograph is valid *only* if taken prior to treatment.

The baseline will serve as a reference point for both the patient and the dentist. Documentation of the baseline shade will help the patient with his perception of treatment success. During the course of the whitening process, he will be able to see the ongoing improvement, and this will further encourage him to continue to actively pursue the home portion of the procedure. After the completion of treatment, a patient who is able to readily observe the visual difference that home tooth whitening has accomplished is also more likely to be satisfied and become an effective referral source.

The baseline is also an important benchmark for the dentist. In the comparative evaluation of various methods of tooth whitening, the efficacy of a product or technique is measured by the difference between the "before" and "after" conditions, and not by the absolute degree of whiteness that has been achieved.

Photographic Evaluation

The most objective form of treatment evaluation currently available is that of photography. The two most common modes of producing the necessary images are 35mm and instant

(Polaroid) photography. In each case, the dentist should attempt to keep the pre- and post-treatment parameters under which the photographs are taken as similar as possible.

The 35mm option involves the use of a suitable 35mm camera with an appropriate macro lens and ring flash such as the Yashica Dental Eye II. (Kyocera America, Inc., San Diego, California)



Fig. 7-1

Standardization of equipment is simple, since it is likely that the dentist will not have changed his photographic apparatus in the span of several weeks. Standardization must also extend to the film type and sensitivity (speed). The same type of film should be used both before and after to permit a true comparison.³ This detail is sometimes ignored, since many practitioners are unaware of the major image differences that various films can impart to the resulting images.

Slides provide the most practical format of 35mm photography for the dentist. The color range and fine grain of slide films can capture the minute details and subtle differences that are so critical in dentistry. Slides are easily portable, ideally suited to presentations, and readily convertible to prints for marketing purposes.

An instant print system such as the Polaroid CU5 has advantages, primarily in internal marketing.^{4,5}

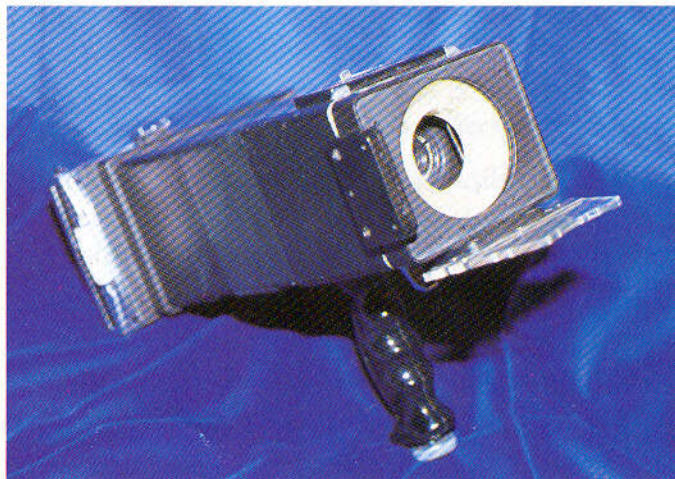


Fig. 7-2

While the color reproduction is sometimes not quite as faithful as 35mm slides, and the detail not as fine, the instant feature allows the dentist to provide immediate photographic evidence of color improvement. This figure shows the results of a photograph taken with slide film and a 35 mm camera.



Fig. 7-3

This is the same picture taken with the CU5. The dentist who restricts his photographic apparatus to the CU5 should also make a set of before and after copies for his own records.



Fig. 7-4

It is useful to include a shade guide tooth in at least one baseline photograph. The selected color tab should be as close to the baseline color of the teeth as possible, with the color rating number visible. The initial picture will thereby simultaneously show the dentition and the chosen shade guide tab. *Photo courtesy of Dr. Dan Fischer.*

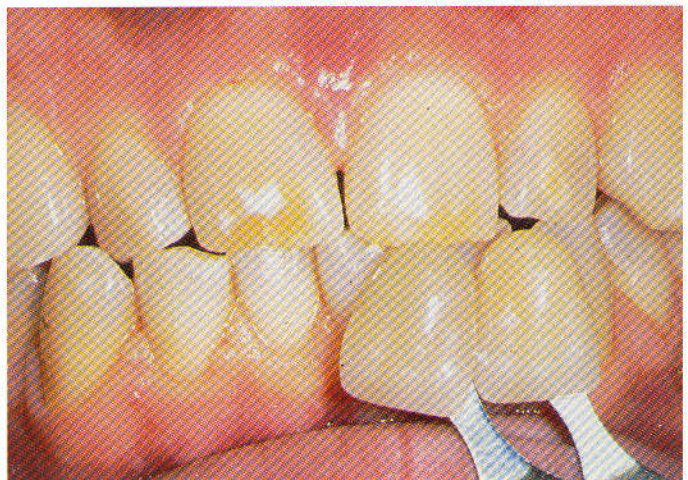


Fig. 7-5

On completion of treatment, a new shade guide tab is selected which reflects the current coloration of the teeth. The new tab will be one or more shade levels lighter than the original one, thus crudely quantifying the degree of whitening achieved. The final picture should include at least one of the shade tabs to serve as a method of evaluating the degree of change brought about by the whitening procedures.

Some dentists even take a final photograph showing the original tabs against the whitened teeth. *Photo courtesy of Dr. Dan Fischer.*

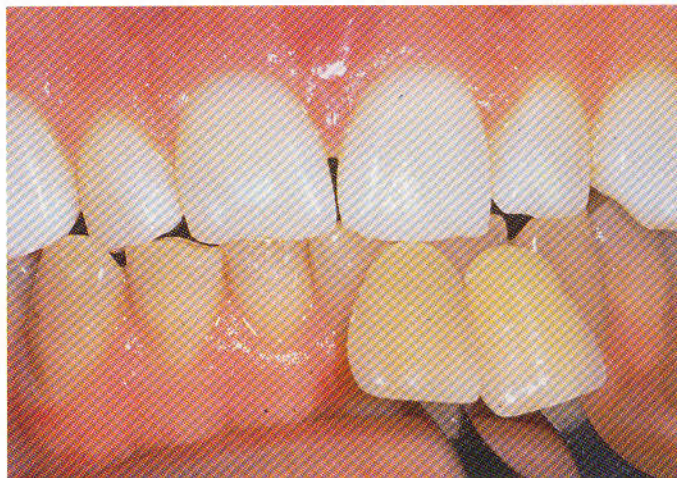


Fig. 7-6

In the marketing of tooth whitening procedures, the most effective form of patient education is a pictorial representation of the "before" and "after" states. The baseline picture is the initial component of this valuable marketing tool, while the completed case picture is the second component.

The legal requirement for pre-treatment records is an accepted condition in other areas of dentistry, and it is just as important in the tooth whitening area. A patient bringing a lawsuit against a dentist could have an advantage in court unless the dentist can clearly demonstrate that both his diagnosis and treatment were justifiable. The court has no means of evaluating the pre-treatment condition of the patient unless records such as baseline photos exist.

Spectrophotometry

Perhaps the most sophisticated and accurate method of tooth shade measurement is the colorimeter. For simplicity in manufacturing, the colorimeters in the past have mostly been of a tristimulus variety. For repetitive measurements on the same tooth under the same lighting conditions, such a unit is effective. Better still is a full-spectrum colorimeter, one which can determine the exact reflective spectra of the tooth being matched. Such a machine is being developed by Bertin and Cie. of France under the direction of Dr. Francois Duret. It is designed to work in conjunction with a microcomputer.

The new full-spectrum colorimeter consists of a portable sensor for measuring the color of teeth, a fiber optic link, a printed circuit board for an IBM PC, and the necessary software.



Fig. 7-7

Tooth shade is determined by placing the sensor tip against the tooth surface while the sensor shoots out a bright flash of full-spectrum light. The computer then analyzes the reflectance and presents a read-out as shown here.

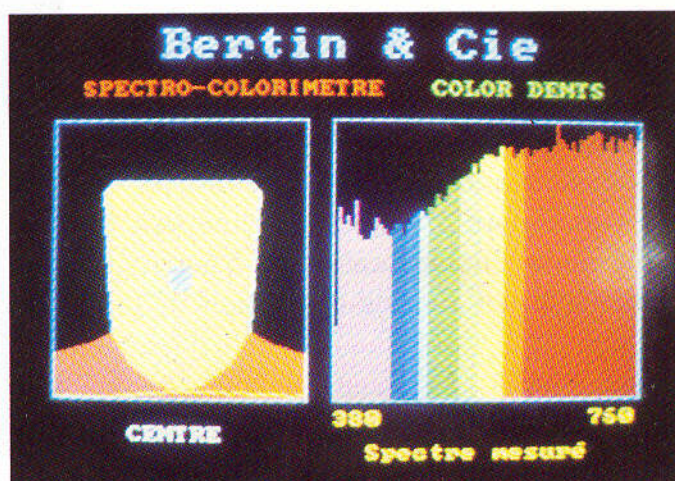


Fig. 7-8

Using computer software, a match is obtained for various manufacturers' porcelains and pigments. The standardized shade tab which most closely matches the tooth is selected. The computer can also be programmed to analyze the shade exactly, rather than "rounding off" to the nearest shade tab. The result is a determination of shade many times more accurate than that performed by the most discerning human eye.

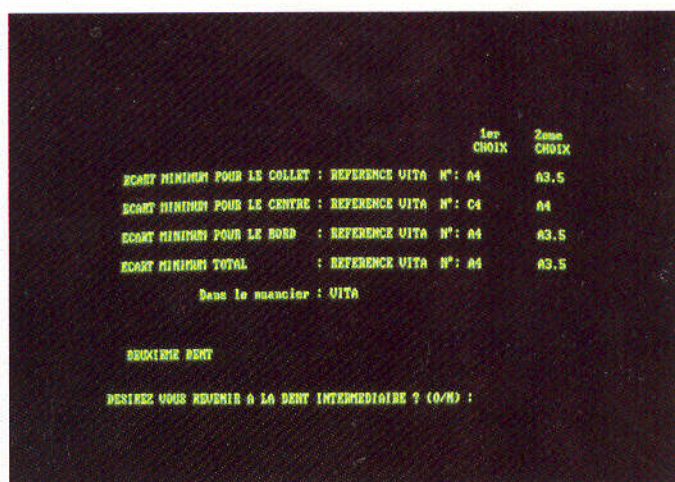


Fig. 7-9

Subjective Evaluation

It is very difficult, particularly for those not trained in distinguishing subtle gradations of yellowish white, to determine whether a color change has actually occurred, and if so, how great the change was. Thus, it is impossible for dentists or patients to make a valid subjective judgment such as "those teeth are whiter now than three weeks ago".

Many factors may influence the perception of color. A suntan will seem to make the teeth whiter, as will makeup (especially dark lipstick). Darker clothing or hair will have the same effect. The ambient lighting and the overall color impact of a room may also cloud our evaluative processes. Most important, over a treatment period of several weeks, we will forget what the originally noted coloration was.

Therefore, attempting to make strictly subjective evaluations of tooth color modification is of dubious value. Instead, we can choose a control baseline that will be in a suitable location for comparison while not altering color itself.



Fig. 7-10

The most practical baseline solution intraorally is the opposing arch. In home bleaching, generally one arch is treated at a time, while the other arch can be used to monitor treatment progress. This is known as comparative evaluation. *Photo courtesy of Dr. Maury Krystell.*



Fig. 7-11

The patient will readily observe the success of the procedure every time he opens his mouth in front of a mirror. *Photo courtesy of Dr. Maury Krystell.*



Fig. 7-12

A comparative evaluation may also be accomplished with a shade guide tab, but this method leaves much room for interpretation, both from the dentist and the patient. Thus its value in determining treatment success is severely limited. Still, because of its ease of use, it is recommended to always take a baseline shade using shade tabs.

TREATMENT EVALUATION

Times of Evaluation

1. Baseline
2. Post-prophylaxis
3. Intermittently throughout treatment (optional)
4. Post-treatment

Methods of Evaluation

1. Photographic evaluation
2. Spectrophotometry
3. Subjective evaluation

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Chapter 8

Marketing

Marketing in dentistry is traditionally divided into two different concepts: internal marketing and external marketing. This division indicates whether the recipient of the dentist's message is someone who is already a patient of the office (internal marketing), or is not yet a patient of the office (external marketing). Both groups are important to the success of any practice, but there are dramatic differences between the proper approach to these two groups. In terms of efficiency, certainly internal marketing is immediately preferable because it is directed towards people who have already selected you as their a dentist. Moreover, once the patient has identifiable problems or conditions, the marketing effort can be specifically tailored to their individual needs.

By comparison, external marketing attempts to not only make people aware of dentistry's ability to answer their dental needs, but must also go further to convince them that you are the person to do it. At the same time, this message must be given without any personal contact to an audience that may or may not have any interest. For this reason, external marketing is a very specialized art which must be mastered to be effective.

Internal Marketing

In cosmetic dentistry, the term "marketing" is usually a misnomer. The process should more properly be called "patient education" since patients are usually conscious of their problems even while often unaware of the possible solutions. Often this need for advice is the very reason that they seek consultation with the dental professional. In some cases, the patient may recognize an undesirable condition but not realize that a potential solution even exists. It is therefore the responsibility of the dental office to inform patients of the appropriate treatment modalities available for their particular set of circumstances. This responsibility is shared by everyone at the office, and it is a good idea for each of the members of the staff to understand his or her role.

Roles in Marketing

The receptionist can guide the patient to pamphlets that discuss various treatment possibilities (Figure 9-1). The receptionist can also discuss in general terms the type of results which the office has experienced with other patients who had similar problems. In this way the receptionist can at least let the patient know that a solution for the problem may be possible.

Receptionist showing a pamphlet to patient.



Fig. 8-1

The hygienist, with a more complete understanding of dental parameters can focus the patient into those treatment choices that are appropriate. Similarly, the assistant is well aware of the procedures that are involved in the various whitening techniques, and can reassure the patient about the treatment comfort and expected results.

It is the dentist who must bring all of this together and serve as the source for information that is not available from the other team members. At times, he will find himself simply reiterating what others in the office have already explained. This is not a waste of time; patients are often reassured hearing information from the dentist. To repeat information is to be more certain that a patient has understood it completely.

It is particularly helpful if the dentist and the staff have themselves undergone tooth whitening procedures (if required). They will be walking demonstrations of the success and appearance of this type of treatment, and the patient will be better able to identify with the end result of the procedure.

Printed Materials

Display material should be prominent where patients are likely to spend time; the reception area, the operatories, and the business office (payment area). While patients are talking or taking care of appointments or bills, they will notice the posted information and ask questions. Knowledgeable staff may be able to direct someone's passing remark into a commitment to treatment.



Fig. 8-2

In addition to posters, pamphlets are readily available for office use. These glossy brochures explain the basics of the tooth whitening procedure and answer some common questions. They also show 'before' and 'after' pictures as examples of expected results.

The low cost of the pamphlets allows the dentist to freely distribute them. They should be placed in the reception area for anyone interested, or included with monthly billing statements. The patient is provided with reliable, albeit generalized, information about this new treatment option, and the dentist is saved from having to answer similar questions dozens of times. Dentists can even personalize these brochures by having their name and telephone numbers imprinted on the pamphlet.

Instant Photography

Personalized "before" and "after" photographs that are given to a patient following treatment are the surest method for having that person motivate his friends and relatives to seek treatment (Figures 8-4 and 8-5). The excitement that an individual will exhibit regarding a recent change (such as having teeth whitened) will wear off within a week or two. Therefore, if the dentist wishes to capitalize on this "excited state", he must deliver the photographs as soon as possible after the completion of treatment, pref-



Fig. 8-3

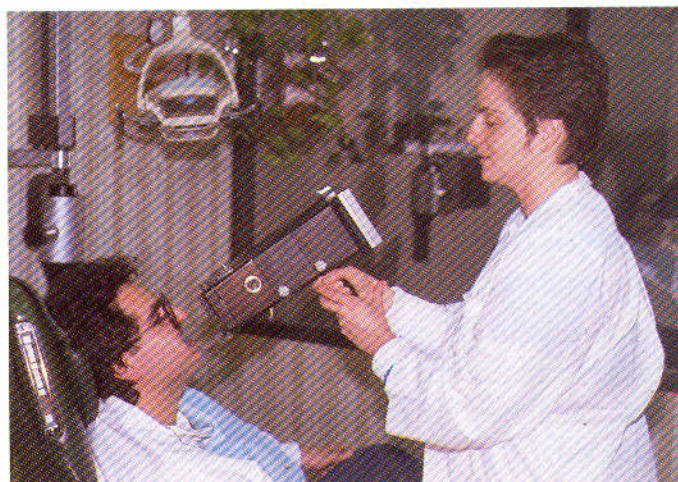


Fig. 8-4

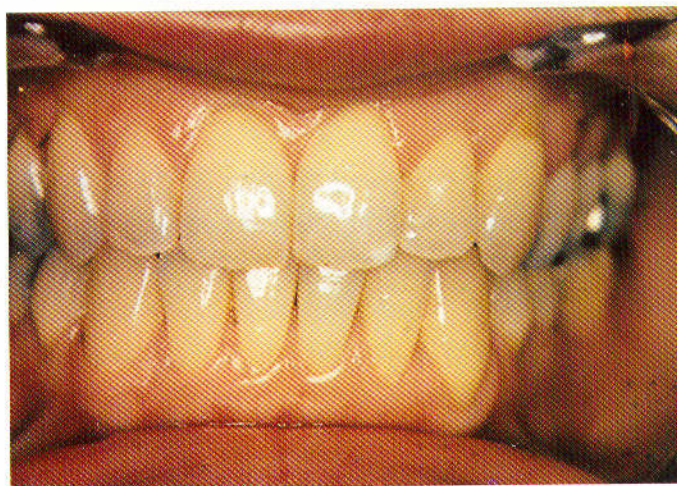


Fig. 8-5

The Polaroid CU5 is an instant print system that is customized for dental photography. Prints are ready within one minute, and the resolution and the color reproduction will demonstrate the changes of tooth whitening very clearly!¹ The camera is easy to use, and the photographs are consistently good. The prints can be given to the patient in a small folder with the dentist's name and number imprinted in case someone wishes to have a similar treatment.



Fig. 8-6

Considering that the active treatment period may last several weeks, some dentists feel it is helpful to give the patient an additional "before" Polaroid to carry around; he might show his improving smile and the baseline comparison photo to acquaintances even prior to the completion of treatment.

Computerized Imaging

Many dental offices today are equipped with an imaging unit, and dentists perform extensive pretreatment cosmetic analyses.* For those offices so equipped, it is very easy to "demonstrate" a tooth whitening procedure on the screen, and many patients become interested in following up with treatment.



Fig. 8-7

It takes only a few moments of the operator's time to show a whitening procedure once the patient is already on the imaging screen. The imaging process will help to establish a common understanding between the patient and the dentist as to the degree of whitening desired and achievable.

Ultimately, the greatest marketing tool for any practice is the enthusiastic response of patients following successful treatment. Tooth whitening is the type of procedure which naturally elicits exactly that type of response.

*New Image, Canoga Park, California.

External Marketing

External marketing is traditionally referred to as advertising. This is a form of patient education that may be accomplished through several venues, some of which may be restricted by the dictates of the local dental jurisdiction. No matter what type of advertising is selected, repetition of a simple message is absolutely vital to the success of any advertising campaign. Unless the dentist is willing to carry out a continuous organized program over a period of at least several months, he will rarely be satisfied with the results.

There are several media which are available for use in advertising. Each of them has advantages and disadvantages. When well done, television advertisements can have the greatest impact on the greatest number of people. It is also the most expensive of the traditional advertising media. Because of the high cost of television advertising, it is vital to create an advertisement which makes extremely efficient use of the few seconds of air time which the dentist will be purchasing. The message must be succinct and appealing both verbally and non-verbally. It is therefore strongly advised that experienced professionals be engaged for the creation of any television advertisements. Only with a well-conceived and well carried out campaign can television be an efficient vehicle for the dentist's message. If these requirements are met, however, television can be perhaps the most powerful tool available for the advertising dentist.

The advertising dentist should not overlook the potential of the more local and less costly cable television stations. Besides being less expensive, the programming on cable stations often appeals to less general audiences than standard commercial television. This specificity in turn attracts an audience with a more predictable interest profile. Thus, cable television often can address a smaller but more interested audience for the advertisement. The result can be more response for less cost.

Radio advertisements are generally less expensive to prepare and air than television spots. Unfortunately, they have limited value in the transmission of cosmetic, and hence visually-oriented, information.

Newspapers and magazines have a wide distribution and can also serve as an appropriate vehicle for dental advertising. As with television and radio advertisements, the dentist should have professional assistance in preparing the commercial. Often it can be advantageous to have professional help in placing the advertisements as well, since the location of the advertisement within the publication will effect its degree of success. The dentist should be certain that the ad will not be "buried" in an uninteresting or inappropriate section.

Telephone directory marketing tends to select for the "emergency-only" type of patient, an individual who may be somewhat less than interested in esthetic dentistry. Still, its low cost is attractive, and is often part of a successful well-coordinated advertising campaign.

Direct mail can also be effectively utilized for advertising. Mailing lists can be obtained which are sorted on the basis of many diverse criteria. Lists can be obtained, for instance, based on personal income, or level of education. Other lists simply include those people who have recently moved into the neighborhood and are unlikely to already have a regular dentist.

Again, through careful use of these lists, the advertising dentist can be selective in the audience for his message, and can correspondingly increase the effectiveness of his campaign.

Anyone who is considering embarking on an advertising campaign should seek the counsel of an experienced agency. If properly used, and when consistent with the image and reality of the dental office, advertising can be an effective method of increasing the demand for the services of the dentist.

If the advertising is not in harmony with the image and reality of the office, the results will either be inadequate or even harmful to the office.

For these offices, the image of being a dentist who advertises is itself inconsistent with the rest of their image. Here the medium of advertising would belie any message which they are presenting.

Effective advertising in dentistry is the exception rather than the rule. Effective advertising is always an expensive long-term venture for the dentist. It is aimed at a largely unresponsive audience that is neither committed to seeking dental treatment, nor to seeing the advertising dentist. Since the copy has to be general in nature, it is difficult for this kind of marketing to impact on the target's specific concerns.

Notwithstanding the above, external marketing can still be effective in mobilizing the dental awareness of the community at large, and in the introduction of a novel technique when:

- a. An office is committed to a well organized, prolonged campaign.
- b. That campaign is effectively targeted to the right audience.
- c. The spoken and unspoken messages of the campaign are consistent with the goals and values of the advertising dental office.

When these criteria are fulfilled, advertising can have a profound impact on the dental practice.

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Chapter 9

Case Presentation

CASE PRESENTATION

Once a patient has been identified as a candidate for a whitening procedure, the dentist (and/or the staff) must communicate both the advantages and the conditions that this treatment involves.

Prognosis

The patient's foremost concern will probably be the prognosis. He may be hoping that following treatment, his teeth will be chalk-white. As always, the dentist must be certain to align the patient's expectations with reality. If the patient's hopes are raised beyond the capacity of the technique, a disillusioned and unhappy patient may trouble the practice for a long time.

It may be difficult to communicate an understanding of the expected color changes to someone who is not trained to translate verbal description to mental imagery. Therefore, a series of presentation adjuncts are listed here that will assist the dentist and his staff in improving their patients' comprehension through visual means. Pictures are much more effective than verbal explanations in that they convey more information, more rapidly.

Arguably, the most demonstrative technique at the disposal of the dentist today is the computerized imaging unit.



Fig. 9-1

The patient's dentition is recorded on the screen, and the operator can whiten the appropriate teeth in moments. The patient can readily observe what effects this would have on the smile, and indeed, on the entire facial appearance. *Photo courtesy of Dr. Sidney Markowitz.*



Fig. 9-2

This form of patient information is clear, personal, and extremely informative. The patient can readily see, in the context of his own face, the changes that the dentist expects to be able to accomplish. He can then ask further appropriate questions (if any) that will help him decide on proceeding.

In the absence of an imaging unit, the dentist can use photographs of previous cases to illustrate the scope of tooth whitening to the patient. While this requires some imagination on the part of the patient, the efficacy of the treatment and the skills of the dentist are both highlighted. The dentist should, preferably, choose the photographs of a case where the problems were similar to the ones that the current patient exhibits.



Fig. 9-3

A number of companies produce patient oriented pamphlets that describe vital tooth whitening. These, of course, are less personal than imaging, and do not reflect the actual work of the dentist, but can inform the patient nonetheless. The advantages of pre-printed literature are that pamphlets are usually professionally and tastefully prepared and that they are useful for those dentists who are not photographically inclined.



Fig. 9-4

When supplementing the spoken word at a consultation, many patients prefer to see "active" information rather than to read it. For this group there are videotapes that convey the information that the dentist is seeking to present.



Fig. 9-5

This delivery mode can actually be advantageous in that it takes up less of the dentist's time as compared to a full consultation. The tape can be shown in the patient education area, and the dentist or staff can come in afterwards to answer questions and be certain that the relevant information was understood. There is little personal contact in this type of approach, but it may suit certain practice philosophies.

The dentist can choose from a number of communicative modes in order to present the above case suggestions, but the following information must be conveyed personally and clearly to be certain that the patient has a complete understanding.

Potential Complications

The complications that can occur with tooth whitening are minimal and usually transient. The incidence of these complications is very low, but the doctor must know about them beforehand so that he is prepared to deal with them if and when they occur.

Treatment for all of these potential complications is straightforward and discussed in the chapter on clinical technique. Usually it simply involves a slight adjustment to the tray or leaving the tray out for one to two days. In all cases, the patient should be instructed to call the dentist if any problem persists. These problems are usually one of the following:

1. Occasionally patients report a slight burning sensation in the throat after using the tray for several days.
2. Sometimes, due to imperfections in the tray, the patient may feel soreness around one or two teeth similar to when wearing an orthodontic appliance.
3. A sensitivity to hot, cold, and/or sweets may arise if the tray's flanges are overextended or if the tray impinges on the marginal gingiva.
4. Rough edges on the tray can cause localized irritations of the gingiva or tongue.
5. There is also a theoretical potential to aggravate temporomandibular joint discomfort if the patient continually bites down on the tray.

Duration of Treatment

The necessary treatment time will be dependent on four factors.

1. **The degree and color of the stain present** – obviously the darker the stain the longer the time to eliminate it. Gray stains are also more difficult to whiten than yellow ones.
2. **The type of stain** – Tetracycline stains, for instance, are more resistant to whitening than the same shade of tooth darkened by age.
3. **The patient's cooperation** – the more regularly the patient wears the tray during the treatment period, the shorter that period will be.
4. **The patient's desired degree of whiteness** – each person has his own idea of how white he wants his teeth to be. Thus, some will opt to continue wearing the appliance a little longer in order to achieve a brighter result.

In general, the treatment period will vary from three to six weeks, and the recommended tray time is 5 to 18 hours a day.

Comfort

The appliance is quite comfortable and permits the wearer to carry out most routine tasks and functions except for eating and drinking. The patient must be told that the dentist should be contacted for further investigation if the appliance is bothersome.

Cost

Prior to commencing treatment, the dentist or the responsible staff person should discuss the financial arrangements with the patient. These must be established and clearly understood by both parties. The discussion should also make clear what charges, if any, will be incurred if the patient loses or needs replacement of the tray.

In general, the patient fee is quoted as a "per arch" amount. Since the upper and lower arches are only rarely done together, the cost for doing both is reasonably double that of a single arch.

There are two major approaches to fee determination in use today and the choice is determined by practice philosophy. The first and more traditional approach dictates that the fees are based on the cost of the materials, the laboratory expenses, and the chair time involved.

The second and more logical approach is based on the value of the service to the patient. Those dentists who understand this system recognize that to establish a fee based upon the cost of materials would be similar to buying fine art by the pound. The end result of the whitening procedure is far more than simply the sum of the various materials used. Without exception, those patients who choose to have their teeth whitened place a high value on the procedure, and are willing to pay a fee which is in keeping with such a valuable service.

CASE PRESENTATION

Prognosis

1. Verbal
2. Imaging
3. Photos of Similar Cases
4. Pamphlets/Literature
5. Videotape

Complications

Duration of Treatment

Comfort

Cost

Chapter 10

Laboratory Technique

Vital home bleaching requires the use of a tray to hold the whitening solution in prolonged contact with the teeth. These trays consist of various plastic materials in sheets of varying thickness. The whitening tray used by White & Brite, for instance, consists of 0.020 inch thickness polyresin material with a semi-porous foam liner bonded to its inner surface.

The laboratory procedure for fabrication of this tray is slightly different from that used for standard acrylic trays.

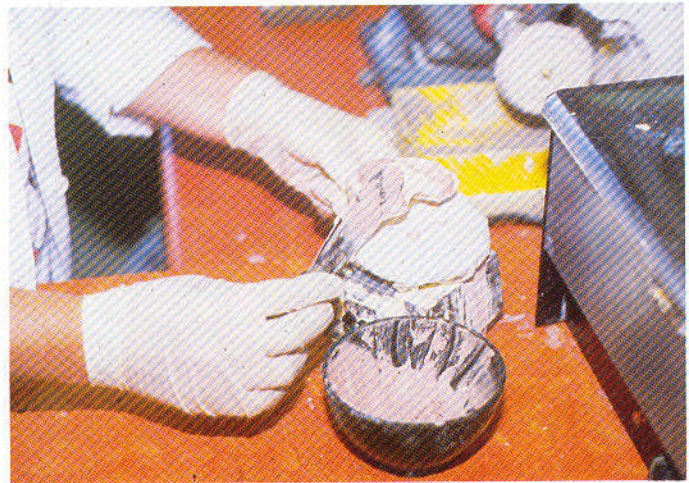


Fig. 10-1

Close adaptation of the tray to the teeth, especially their facial aspects, is of critical importance. As a result, the model is trimmed differently from other procedures. In orthodontics, the study models are trimmed in a standard fashion, with a nice even rim of stone clearly delineating the dimensions of the buccal fold.

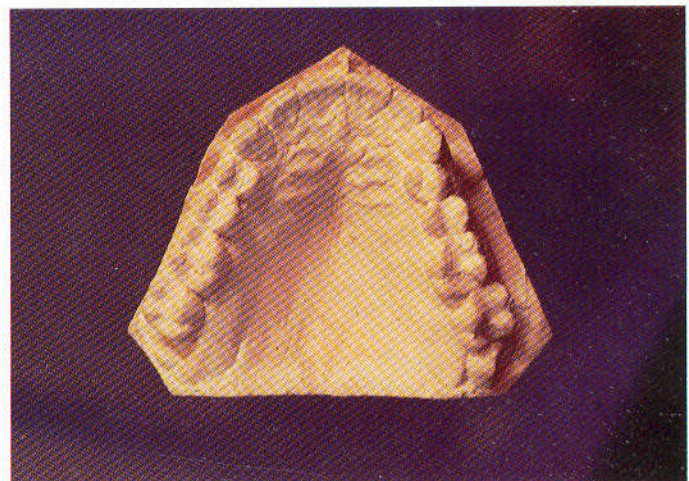


Fig. 10-2

While this system of model trimming is appropriate for orthodontic purposes, the flange of stone will prevent close adaptation of the polyresin tray along the gingival margins.

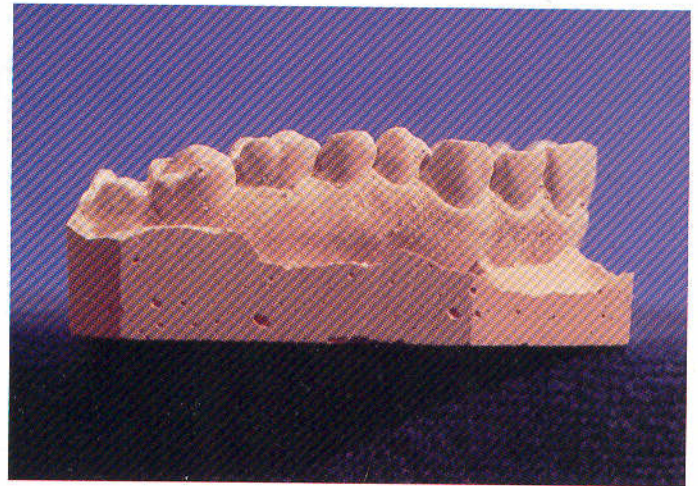


Fig. 10-3

When fabricating a tray for tooth whitening, it is best to completely eliminate any stone which extends farther facially than the tooth or gingiva which is to be covered by the tray.

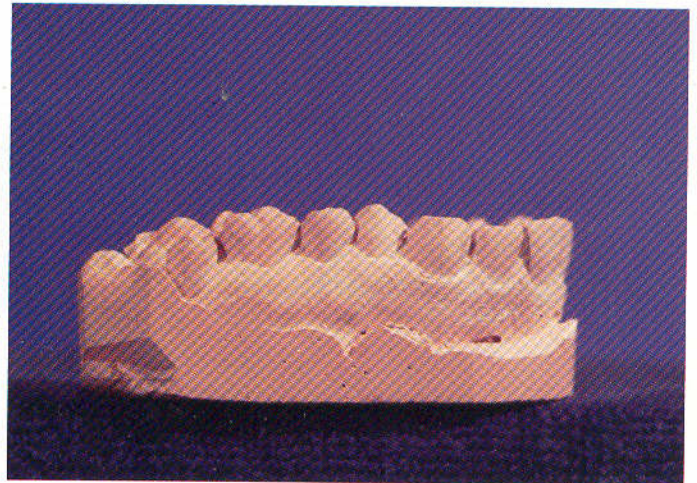


Fig. 10-4

In fact, many technicians feel that they get improved results if the platform of the model trimmer is tilted in a slight downward position when the buccal flange is trimmed.



Fig. 10-5

When this is done, the resultant model has a base which slopes away from the critical areas of the teeth, and thus avoids any possible interference during the vacu-forming stage.

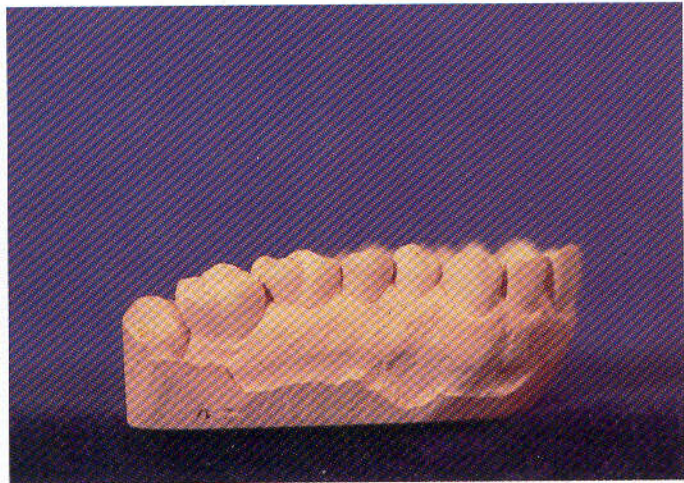


Fig. 10-6

Lingually, any potential interference in vacu-forming by the model base is eliminated by trimming the model in a similar manner using a lathe.



Fig. 10-7

This can also be accomplished using a coping saw.

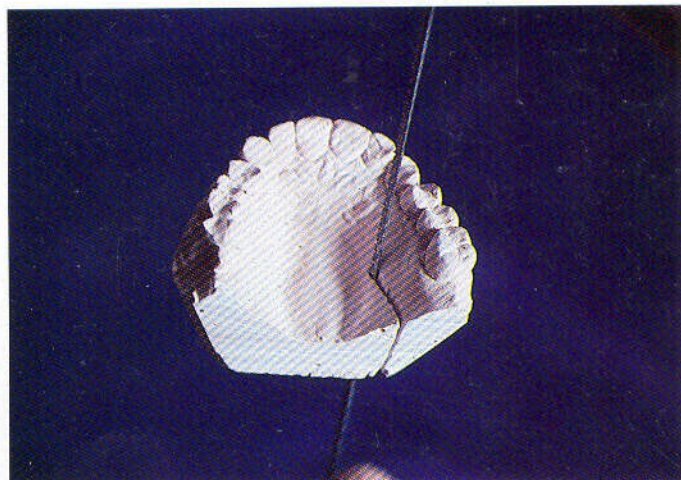


Fig. 10-8

The final design of the model as seen from the occlusal is shown in this figure.

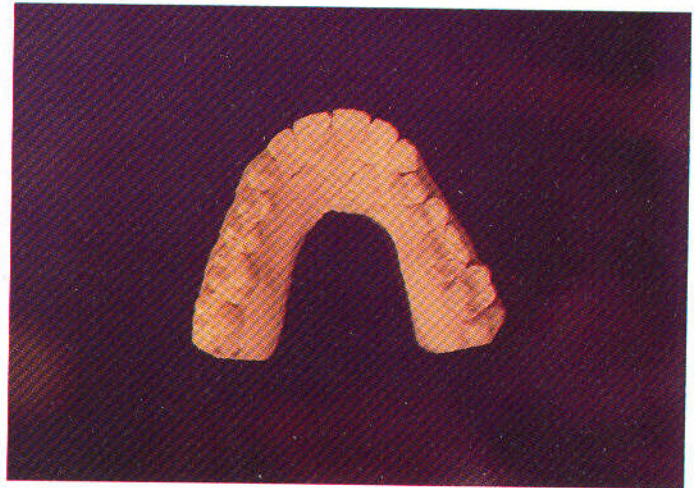


Fig. 10-9

Much time can be saved by removing most of the stone from the lingual areas while the model is setting.

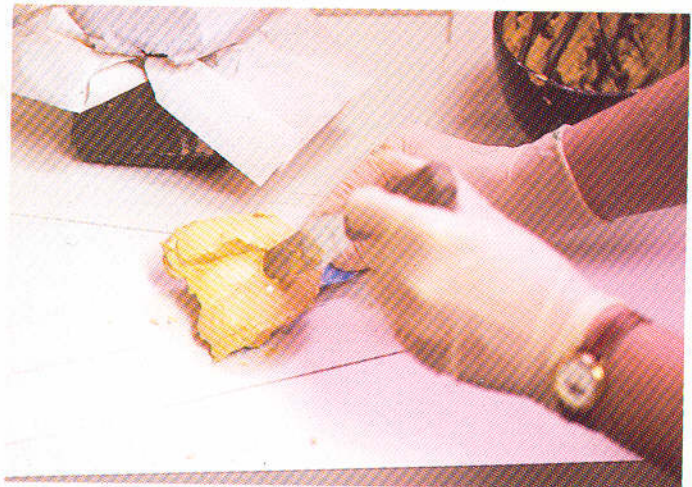


Fig. 10-10

One final modification of the usual laboratory procedure is yet to be made. In order to bring the polyresin into more intimate contact with the facial dimension of the model, the anterior of the model is often raised up on the vacuformer by placing a Q-tip or two pennies under the anterior portion of the model.

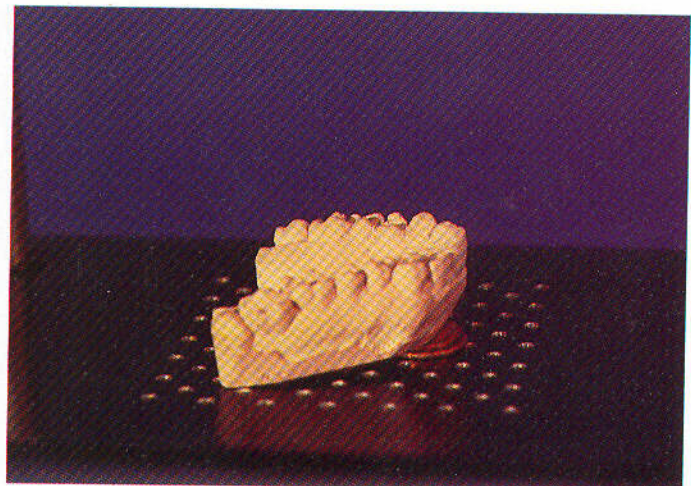


Fig. 10-11

An alternative method is to trim the base in such a way that the plane of occlusion is not parallel to the base, with the anterior section being raised about 3-4 mm above the posterior section. If large undercuts are present, block-out material such as modeling clay can be used to prevent locking the tray on the cast during fabrication. Obviously, wax would not be a good material for this purpose due to the temperature reached in the vacuform process.

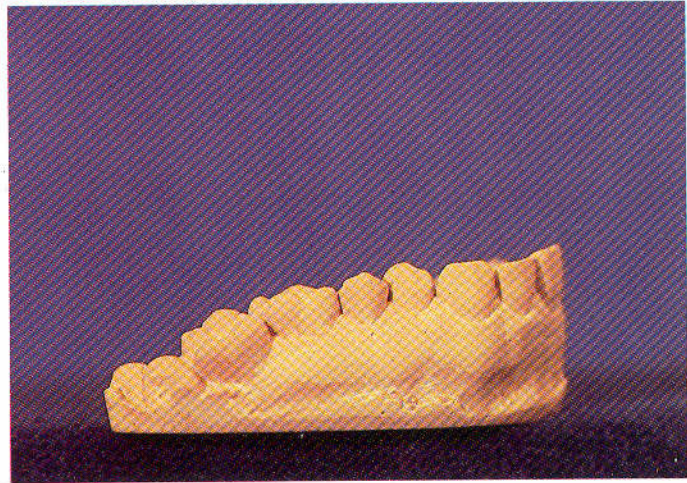


Fig. 10-12

Once the model is poured and trimmed, the next step is to form the polyresin tray over the model. Any standard vacuform machine is used for this purpose, so long as the vacuum power is adequate. Pictured here is the Omnii-Vac.

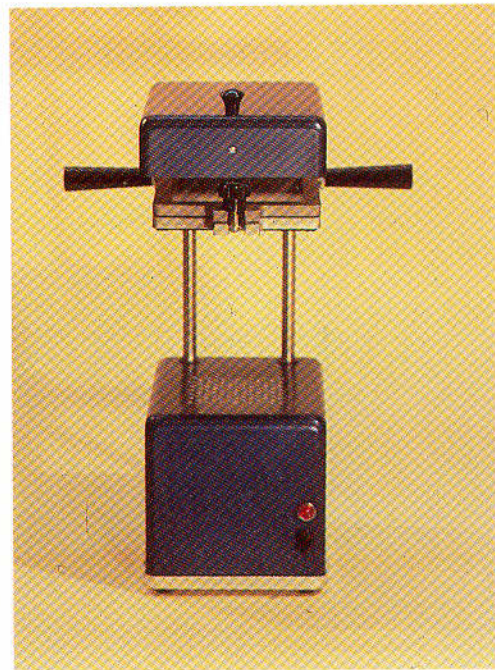


Fig. 10-13

The sheet holder is held in place by the pressure of the handles against the vertical guide posts. To raise or lower the sheet holder, simply loosen both handles, place the holder into the desired position, and slightly tighten the handles.

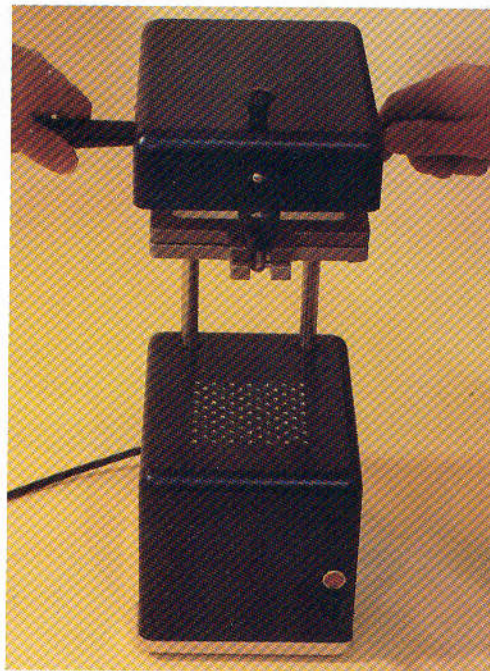


Fig. 10-14

The sheet holder is lowered and the heating element of the vacuformer is swung away for easy access (Figures 10-15 through 10-18).

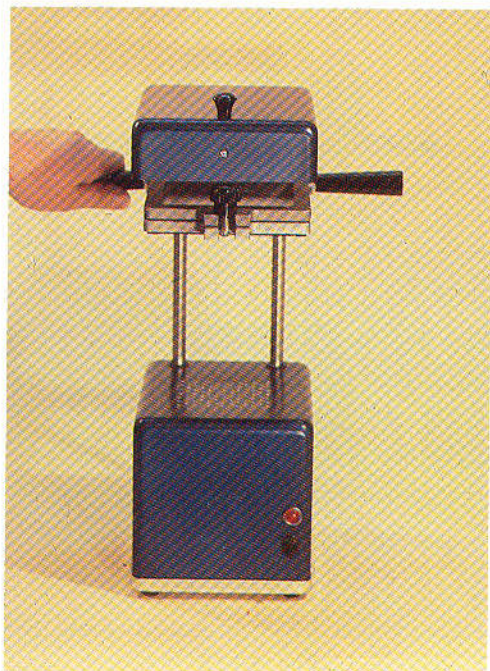


Fig. 10-15



Fig. 10-16

Sheet holder lowered with heating element swung away.

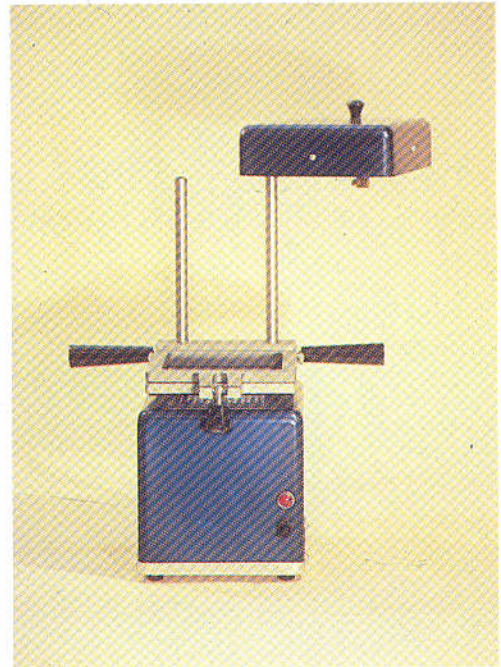


Fig. 10-17

The top half of the holder is then opened, ready for placement of the polyresin tray material.



Fig. 10-18

The corners of the tray material may need to be cut off to allow it to fit in the holder.

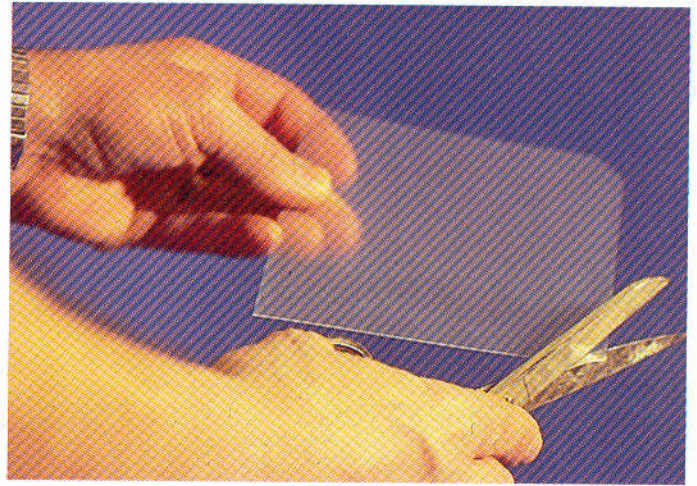


Fig. 10-19

The two surfaces of the polyresin tray material provided by Omnii are not alike. One side is shiny and the other has a dull, almost frosted finish. The material is placed into the sheet holder with the shiny side up (Figures 10-20 and 10-21).

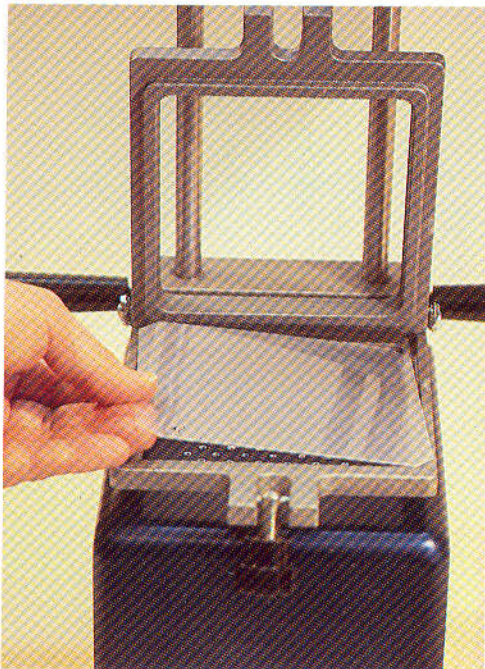


Fig. 10-20



Fig. 10-21

The heating element is then swung back into place and the sheet holder is raised up to the heating element. The sheet holder should not come closer than one inch from the heating element, or uneven heating of the sheet will occur.



Fig. 10-22

The model is placed on the vacuum platform. Some technicians prefer to have the anterior teeth placed over the center of the platform (feeling that this will maximize the amount of suction in the critical anterior area), while others prefer to center the whole model. There is no data to support either position, so the exact placement of the model is a point of personal preference.

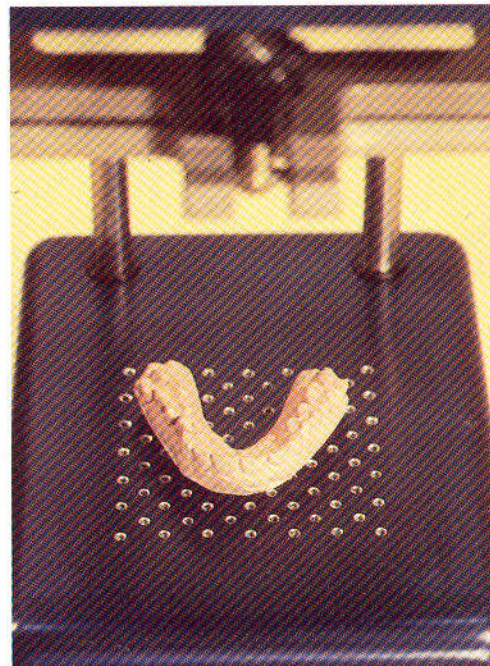


Fig. 10-23

The semi-porous foam insert is then prepared to fit over the model. It should be large enough to cover all of the teeth, but no larger than necessary. This is because the insert will cut down on the total amount of suction which is applied to the heated polyresin sheet. Most commonly, the foam insert is simply cut to a square shape about 1 cm smaller than the polyresin sheet on each side.

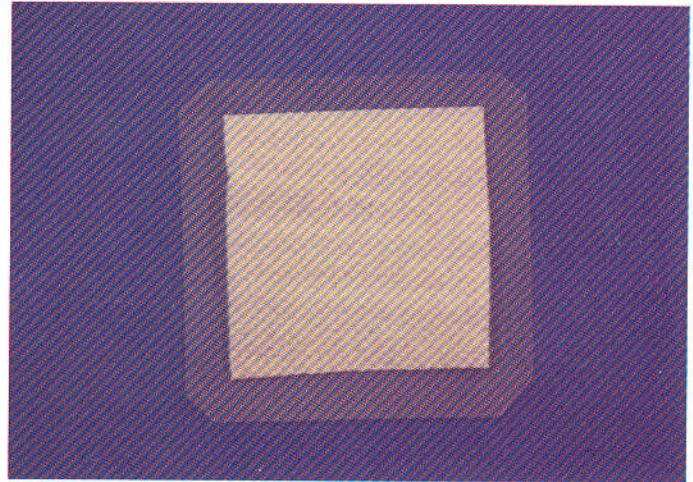


Fig. 10-24

To facilitate close adaptation of the tray on the lingual, a "V" is cut out of the insert material in the region of the palate or tongue. The insert is NOT placed over the model at this time.

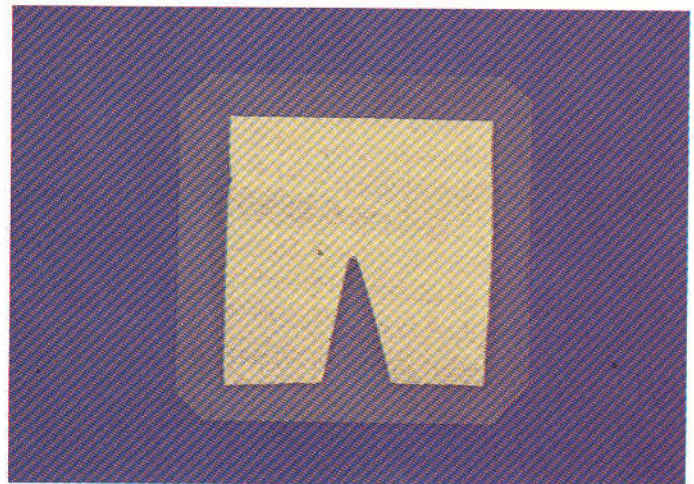


Fig. 10-25

The heat is then turned on. As the tray material begins to heat it will go through several stages. First it will begin to wrinkle slightly and perhaps even sag a bit in the center.

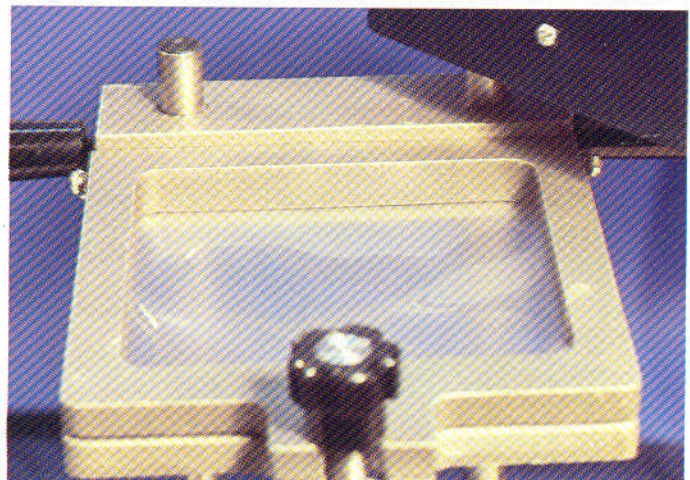


Fig. 10-26

Then after a minute or so, the wrinkles will begin to smooth out again, and the tray material will become nearly transparent.

Here the heated material is halfway ready.

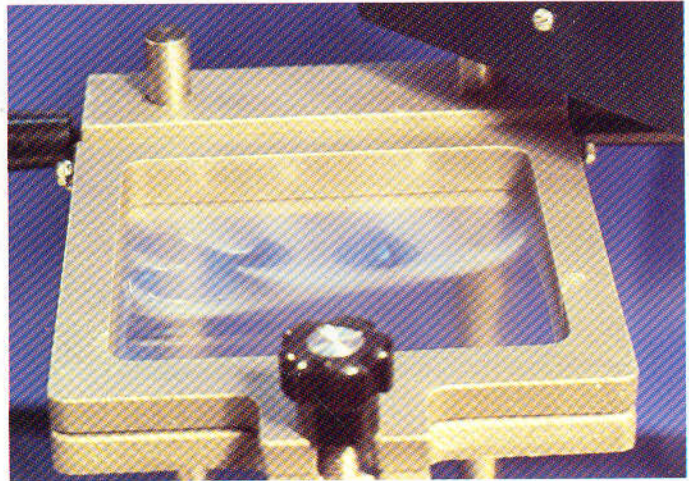


Fig. 10-27

Here the heated material is ready to go.

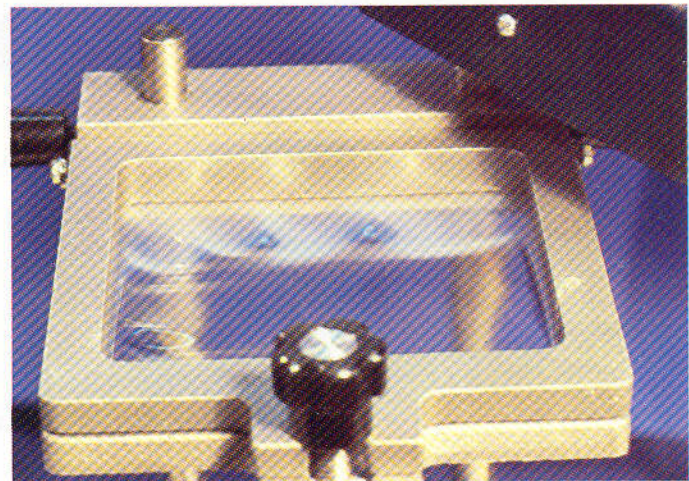


Fig. 10-28

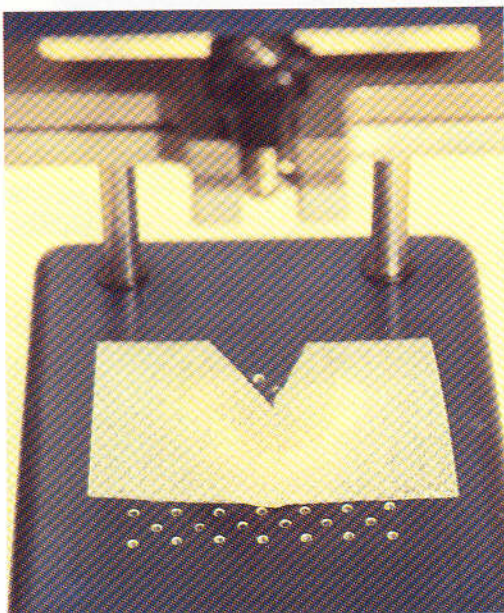


Fig. 10-29

At this point it is ready to be lowered over the model. The prepared foam insert is placed over the occlusal surfaces of the model.

If the sheet is allowed to overheat substantially, the sheet will sag well below the level of the sheet holder and will melt the insert during the following steps.

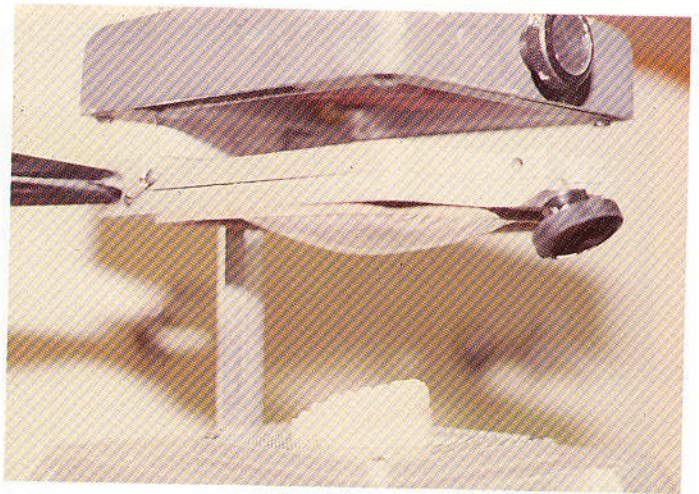


Fig. 10-30

With the heat still on, completely lower the polyresin sheet over the model and the foam insert.

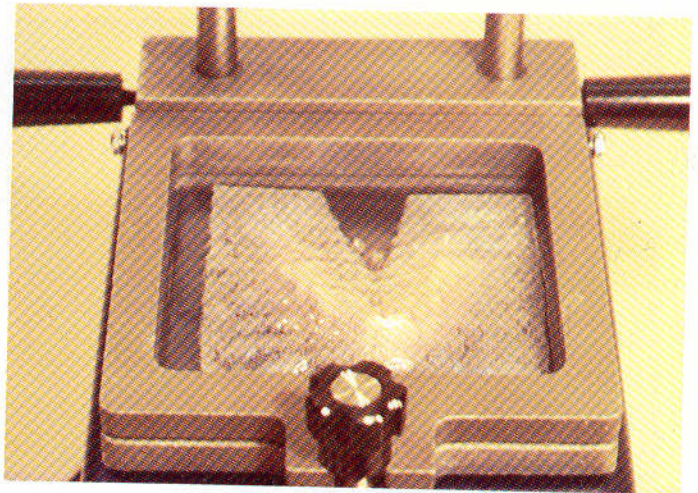


Fig. 10-31

As soon as the tray holder is in place, turn off the heat and immediately turn on the vacuum.

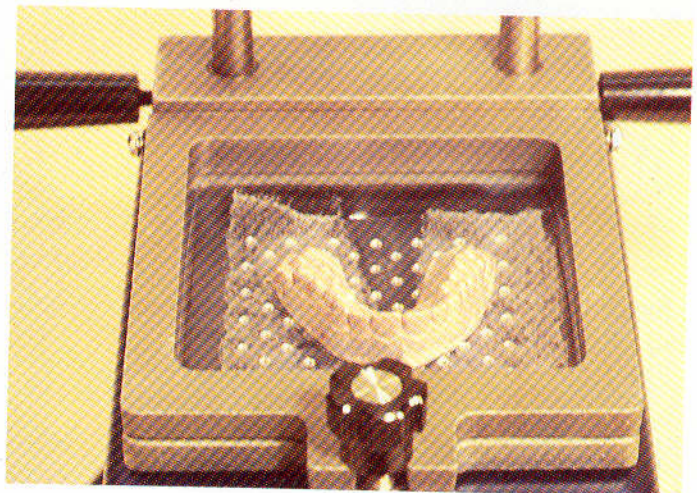


Fig. 10-32

Quickly inspect the tray while it is still warm. If there are any wrinkles in the plastic in areas which are to be used, these should be immediately smoothed out using a pencil eraser.

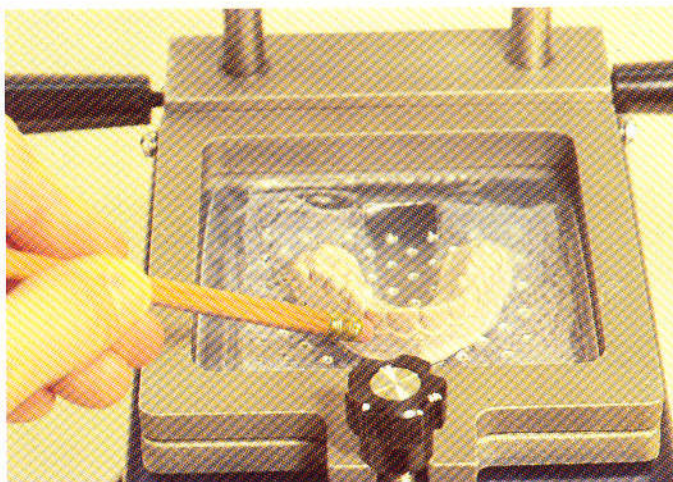


Fig. 10-33

Leave the vacuum on until the tray has cooled. When the tray holder has cooled enough to touch without getting burned, swing away the heating element, and remove the tray and model.

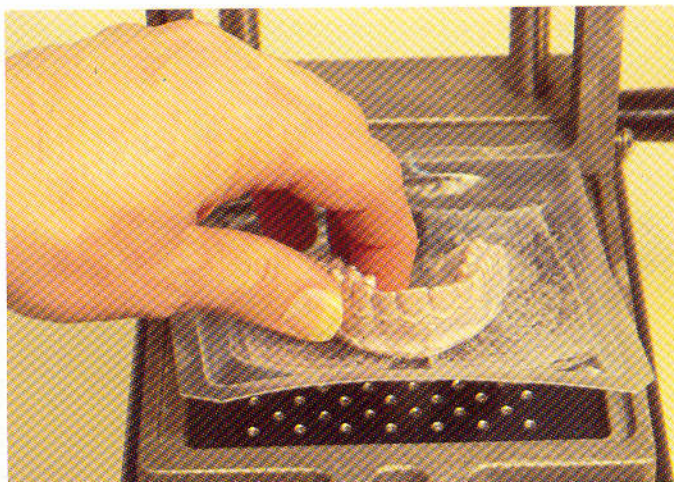


Fig. 10-34

Cut away the gross areas of excess tray material with scissors to facilitate handling the model in the next steps.

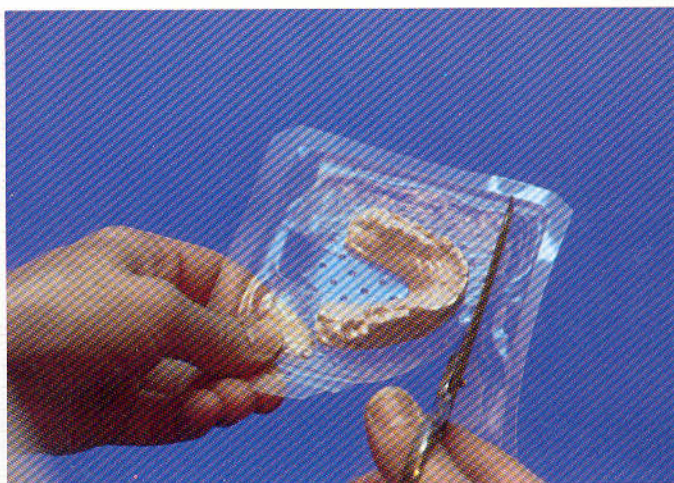


Fig. 10-35

A scalpel is used to trim the tray to the desired final outline. This outline should include from one to two millimeters of gingiva along the facial margins.

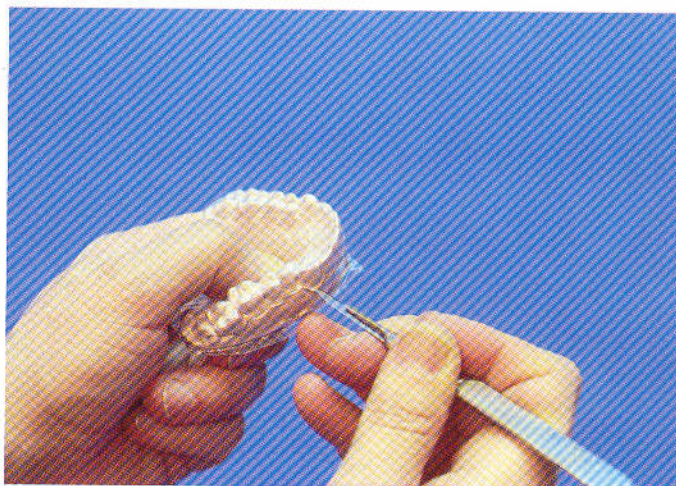


Fig. 10-36

This is a side view of the model with the outline of the correct tray design.

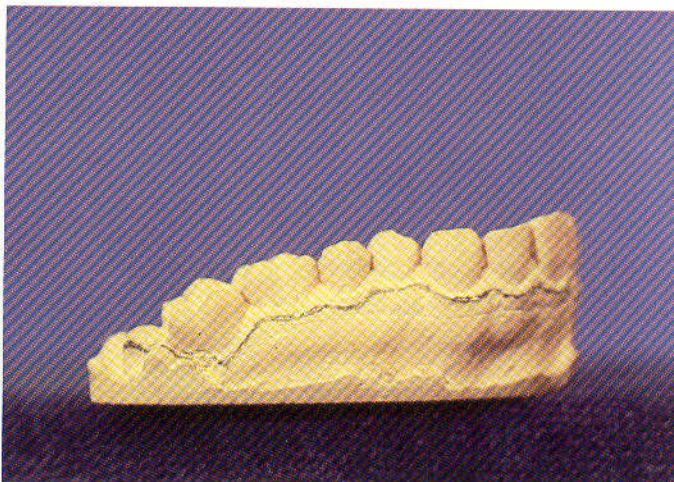


Fig. 10-37

Earlier tray designs covered more of the gingiva on the facial. While this tray design was adequate for whitening, it would sometimes result in a transient hypersensitivity of some teeth.

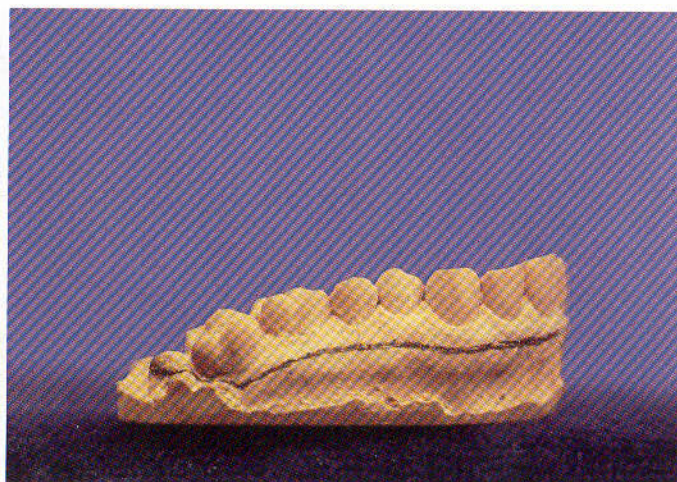


Fig. 10-38

Lingually, the tray should not extend over the gingiva at all. The lingual view shows the penciled outline on the model.

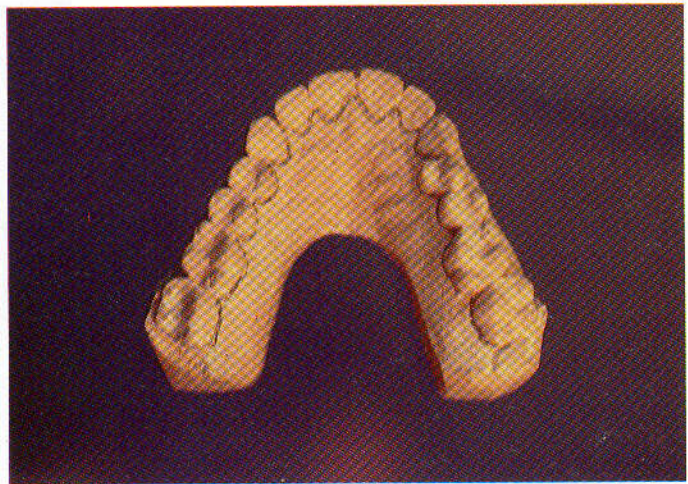


Fig. 10-39

After cutting through the tray material with a scalpel, peel away the excess polyresin.

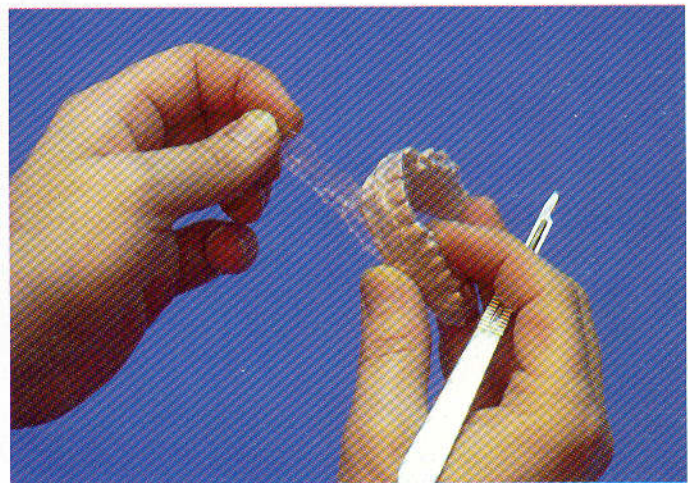


Fig. 10-40

Since the tray material is flexible, it is an easy matter to remove the tray from the model once it has been trimmed.

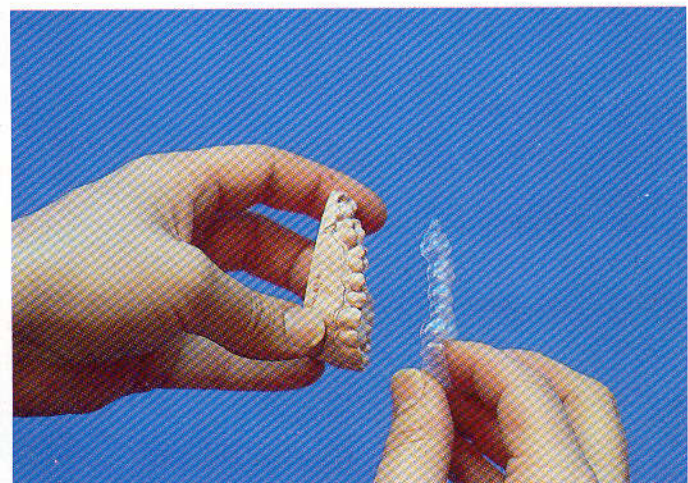


Fig. 10-41

After removing the tray from the model, inspect the edges to be certain there are no burrs or catches which might cause irritation.

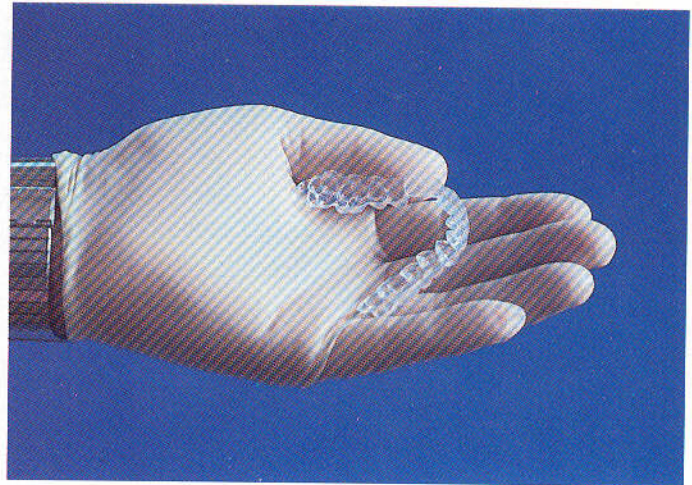


Fig. 10-42

Also check again for any wrinkles in the tray material. If any are found, they can usually be removed using a green stone in a slow speed handpiece. (Shofu, Menlo Park, California)

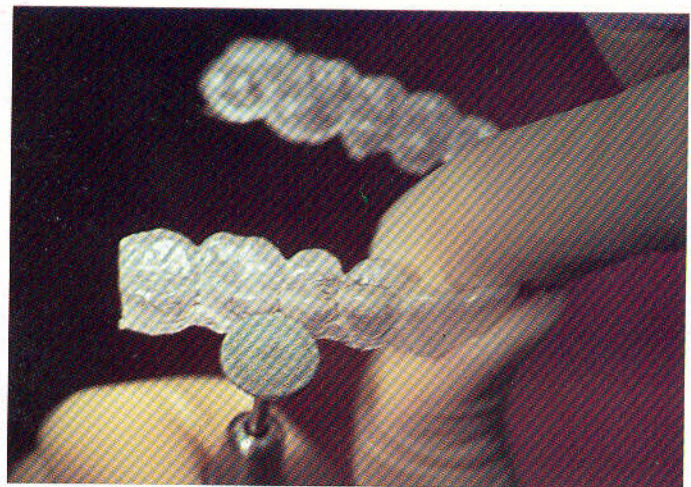


Fig. 10-43

Sometimes the tray will need some final adjustment. This is most easily accomplished using a small pair of sharp scissors.

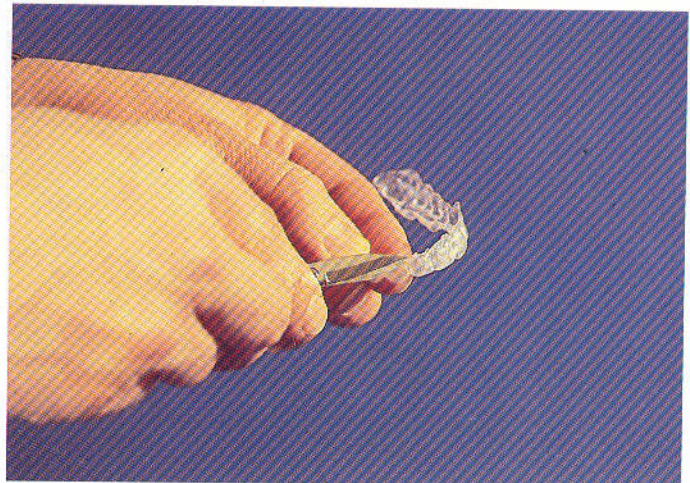


Fig. 10-44

The completed tray should be kept on the model and moist until delivery to the patient.

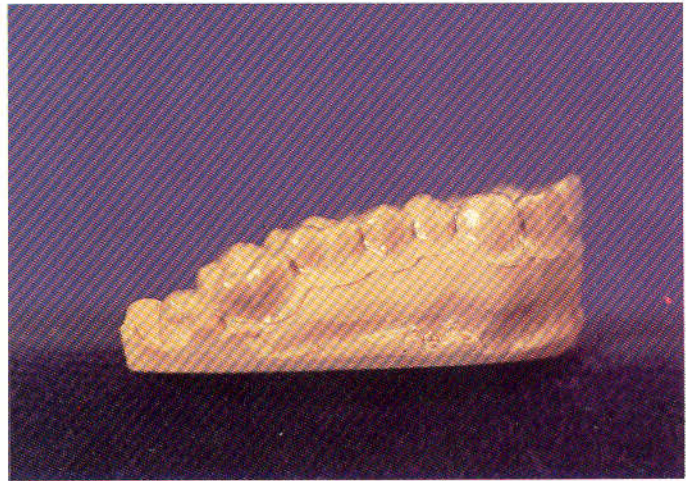


Fig. 10-45

Chapter 11

Complex Cases

Generalized Tooth Whitening

It is now well documented that vital tooth whitening is effective on all structures of the tooth, whitening enamel, dentin, and cementum.^{1,2,3} In addition, one of the most startling discoveries by the research team at the University of Alabama was the fact that even portions of the tooth not directly in contact with White & Brite solution were lightened when other parts of the tooth were exposed.

This has major implications for the dentist providing home tooth whitening for his patients. The result of this property is that the dentist need not fear inadvertently whitening only a portion of the tooth while leaving the rest unchanged. *If the whitening process is continued long enough*, the entire tooth will be effected. Thus, the fact that the incisal edges of the maxillary teeth may be in contact with the whitening solution for a longer time than the gingival areas is not a worry, provided that sufficient total time is allowed for complete whitening.

For a demonstration of this phenomenon, we used an extracted heavily stained tooth. Then we continually bathed a small section of the root and crown in the whitening solution.



Fig. 11-1

The area which was kept constantly moist with solution is depicted in this schematic diagram.

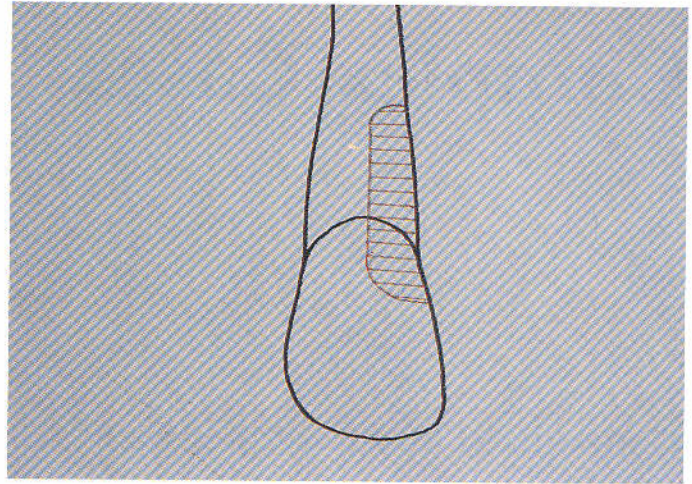


Fig. 11-2

After 72 hours, the results were dramatic.

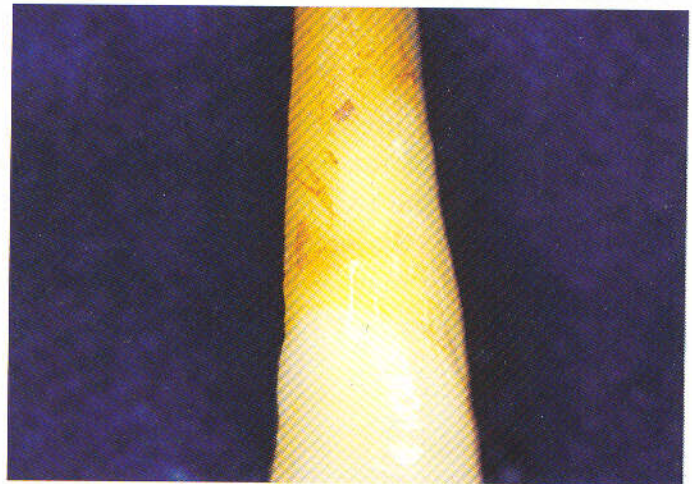


Fig. 11-3

Notice that the liquid clearly whitened both cementum and enamel where it came in contact with the tooth, but it also whitened the tooth in areas where no direct contact with the liquid took place.



Fig. 11-4

Dealing with Tetracycline Stains

Tetracycline stains are one of the most difficult discolorations for the esthetic dentist and one of the most disheartening for the patient. The first treatment of choice is vital tooth whitening. This procedure alone may produce completely satisfactory results, particularly if the teeth exhibit a yellow or brown discoloration, as shown here, rather than a gray or blue hue. *Photo courtesy of Dr. Dan Darnell.*



Fig. 11-5

The results can be extremely satisfying using tooth whitening. *Photo courtesy of Dr. Dan Darnell.*



Fig. 11-6

Often, however, the result of the vital tooth whitening is only to lessen the amount of difference visible between the darkened and normal shaded sections of the tooth. In this example, the dark areas on the mandibular teeth were extremely dark prior to vital tooth whitening. *Photo courtesy of Dr. Dan Darnell.*



Fig. 11-7

After vital tooth whitening there was a vast improvement, but perfection was not attainable with tooth whitening alone. Sometimes it is necessary to follow up the whitening with veneering or bonding. *Photo courtesy of Dr. Dan Darnell*

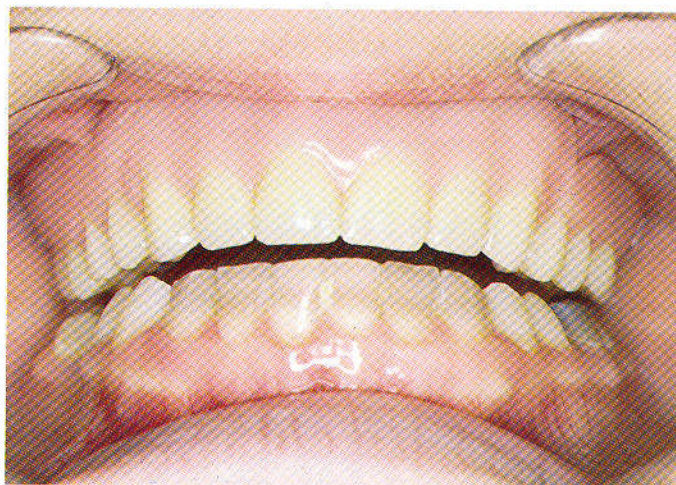


Fig. 11-8

Even when subsequent porcelain veneering is anticipated, the first order of treatment is still to utilize vital tooth whitening. By far the most difficult bonding procedure is to attempt to drastically alter the shade of a tooth. The dentist must either settle for a very thick addition of material to the surface of the tooth in order to mask the dark shade, or settle for a thin but extremely opaque and lifeless looking restoration. Alternatively, the dentist can utilize a Maximum Preparation (Type V),⁵ reducing as much enamel as possible in the attempt to keep the bonded layer from adding too much bulk to the tooth morphology. Obviously, the less dark the tooth is prior to bonding, the more conservative the dentist can be when masking the discolorations.

Dealing with Fluorosis

Dental Fluorosis manifests itself in a wide variety of discolorations, ranging from a chalk-white to a dark cocoa brown. The stains may also be in the superficial aspects of the enamel, or may range throughout the enamel structure. Proper treatment therefore can require utilization of several modifications of the basic tooth whitening procedure. On occasion, vital tooth whitening is not even necessary.

If there is any reasonable chance that some of the discoloration is superficial, those areas of stain should be abraded. This treatment can be as simple as using a polishing disk or very fine diamond to remove the surface enamel. Some clinicians advocate the use of a pumice/hydrochloric acid paste used with a wooden burnisher to abrade past the stained area. Obviously extreme prudence must be exercised when using such caustic agents.

The abrasion will remove that part of the stain which is on the surface. Often this will be all the treatment that is needed.

If the problem still is not resolved, however, further steps can be taken. Obviously any tooth whitening procedure will not be effective in removing opaque white discolorations. By lightening the shade of the neighboring tooth structure, however, the opaque white areas will

seem less noticeable. Dark areas are usually improved or completely removed by the vital tooth whitening procedures. If the overall tooth shade is nearly the ideal shade, and the tooth exhibits some dark areas, the dentist may elect to utilize the selective whitening procedures discussed later in this chapter.

Even with the greatest of skill on the part of the dentist, often perfection can only be achieved through a combination of abrasion, tooth whitening, and bonding.

Dealing with uneven coloration from tooth to tooth

This situation is actually extremely simple to handle. The whitening effect works most quickly on those teeth which are the darkest, and more slowly as they approach full potential whiteness. The result is that the dentist need not take any special steps if the desire is for bright, evenly matched teeth. If some of the teeth are already exactly the desired shade, however, the dentist may wish to utilize some of the techniques for selective whitening discussed later in this chapter.

Whitening Prior to Porcelain Veneering

Again, no special steps need to be taken for this situation. An early concern regarding vital tooth whitening was the fear that the enamel may in some way become less receptive to traditional bonding after treatment. Careful studies by Titley¹ have shown this to be an unfounded fear. Not only is tooth whitening possible prior to bonding, but is often desirable. The closer the actual tooth can come to the desired final shade, the more translucent and lifelike can be the bonded restoration.

Whitening After Bonding

Since it is possible to whiten parts of a tooth which have not come in direct contact with the whitening solution, it is possible to whiten teeth underneath bonded materials. The bonded materials (porcelain or composite) will not normally be whitened by the solution, but some whitening may be observed as a result of the lightening of the tooth structure under the restoration. Remember, however, that it may take long exposure to the whitening liquid before enough of it "soaks through" under the bonding. Also, if the tooth was dark to begin with, the bonded material was probably selected to be particularly opaque. This will minimize any improvement created by the whitening.

The ideal situation for whitening after bonding is the tooth which was bonded with porcelain for reasons of improper shape (such as a chipped corner) and which subsequently darkened due to pulpal recession. Here the veneer is composed of relatively translucent porcelain, and a change in shade of the tooth will be apparent through the veneer.

There is one caution to be observed when whitening teeth under bonding. Some composite materials are adversely effected by submersion in the whitening liquid. Different composites are effected to greater or lesser extent than others. Depending upon the specific composite utilized, it is possible that the bonding may need to be re-polished or even replaced after the whitening.

Selective Whitening

Speeding up the whitening process in selected areas.

Most people who avail themselves of vital tooth whitening are seeking generally whiter teeth. There are times when we would like to selectively whiten only certain teeth, or even certain portions of individual teeth. While it is true that the entire tooth is whitened even when only a portion of it is exposed to the whitening solution, the dentist can have an effect on the *rate* of whitening in specific areas. Using this tool, the dentist can therefore selectively whiten certain areas more or less than the neighboring areas.

At this point we know of three ways to substantially speed up the whitening process, and one method of slowing it down. All four of these methods can be used to achieve uneven whitening on the teeth.

I. Selective Liner Placement. The first method of locally speeding up the rate of whitening is through the use of the foam tray liner. As dentists began to use the foam liner in the whitening tray, the entire whitening procedure was greatly accelerated. The clinical impression is that the whitening is accelerated by a factor of two.

Normally, the dentist and patient would like the fastest, most efficient way to brighten all the teeth. On occasion, however, it is desirable to lighten a single tooth substantially more than the others. Such was the case with this patient's maxillary right cuspid.



Fig. 11-9

One way to achieve single tooth whitening is to selectively place the foam liner. This is actually rather easy to do. After pouring and trimming the model, a strip of foam liner about 4cm long and one tooth wide is cut from a sheet of X-Cell. The strip is then placed over the model of the tooth from buccal fold to lingual, and taped in place using adhesive tape. The tape should be placed in such a way that it will not be covering any area of the X-Cell which will become part of the finished tray.

The tray is prepared in the usual manner, except that the model is placed on the vacuformer platform immediately before the heated polyresin sheet is lowered.

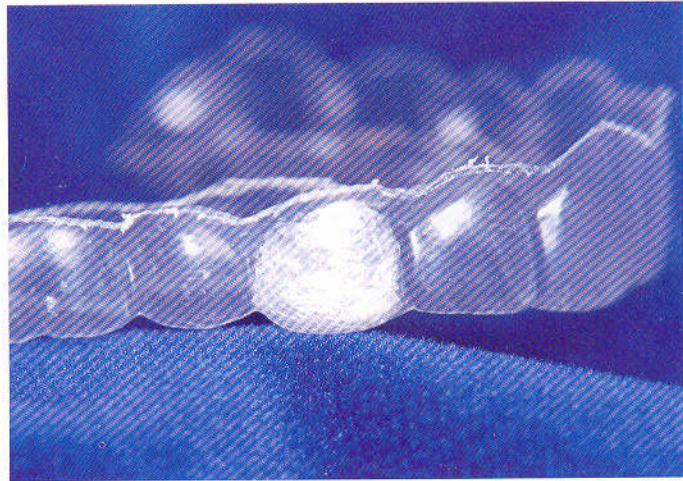


Fig. 11-10

The final result is a tray with a foam liner on only one tooth.

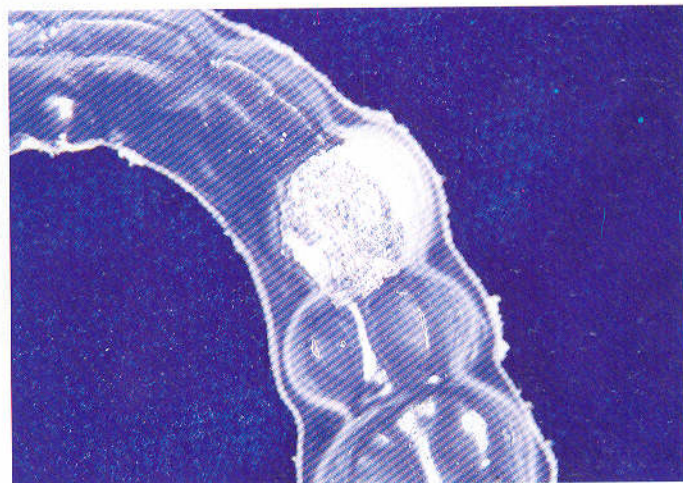


Fig. 11-11

If the goal is to whiten all of the teeth, with an accelerated whitening in the darkened tooth, the patient is then instructed to place the whitening liquid in the tray in the usual manner. If the desired result is to whiten only the darkened tooth, then the patient is instructed to place the liquid only in that portion of the tray which has the liner. This photograph shows the result of such a protocol. The darkened tooth was lightened more than the neighboring teeth.

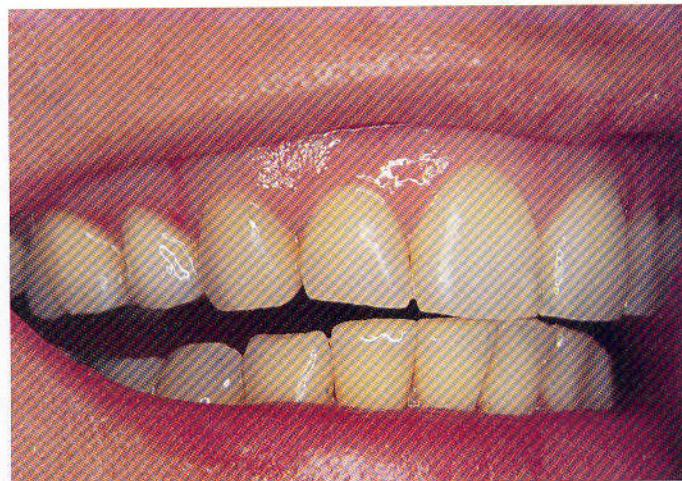


Fig. 11-12

II. Selective Etching. The second way to accelerate the whitening process in selected areas, is to selectively etch the teeth prior to whitening. Some operators use 35% orthophosphoric acid, while others prefer to use the acidulated fluoro-phosphate gels which are normally reserved for children's office fluoride treatments. The effect achieved by the orthophosphoric acid is much more dramatic, but also requires a follow-up visit to polish the teeth after the procedure is completed.

To illustrate how the etching can accelerate the whitening process, a dark extracted tooth was selected.



Fig. 11-13

Then we arbitrarily assigned one-half of the tooth as the area to be etched.

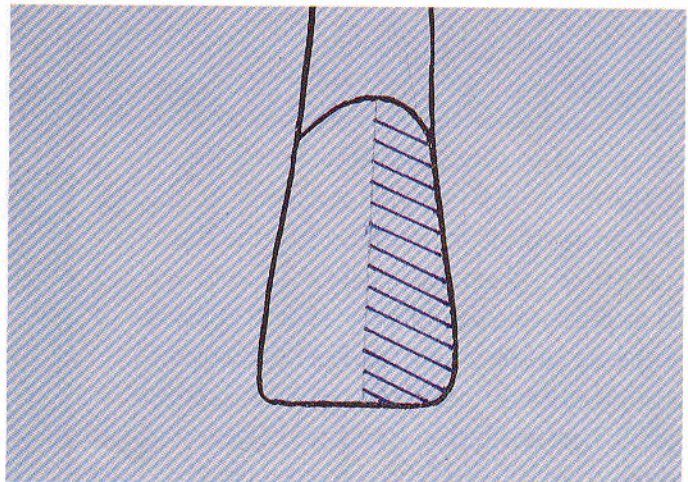


Fig. 11-14

A 35% phosphoric acid gel was placed on the test area for 60 seconds and then thoroughly rinsed and dried.



Fig. 11-15

The apparent immediate bleaching is primarily due to the frosted effect of the etched dried tooth, although some of the whitening is due to the dissolution of surface stains.



Fig. 11-16

After 120 hours submersion in whitening solution, the etched area is still slightly more whitened than the non-etched area.

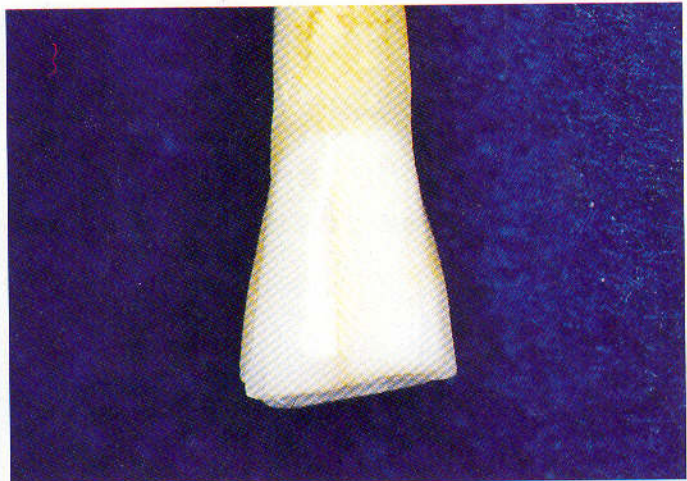


Fig. 11-17

If the whitening continues, however, the rest of the tooth eventually catches up with the etched area. Thus, etching, like the foam liner, is a means of *speeding up* the whitening process, not increasing the degree of final whiteness. If the dentist wishes to whiten all the teeth to their full potential, then etching is not necessary.

III. Selective Sandblasting. The third way to speed up the whitening process is through the use of a small portable sandblaster. (*Danville Engineering, Inc.; Danville, California*)

To demonstrate the relative effectiveness of this technique a darkened extracted tooth was again chosen.



Fig. 11-18

Next, we sandblasted the incisal half of the tooth.

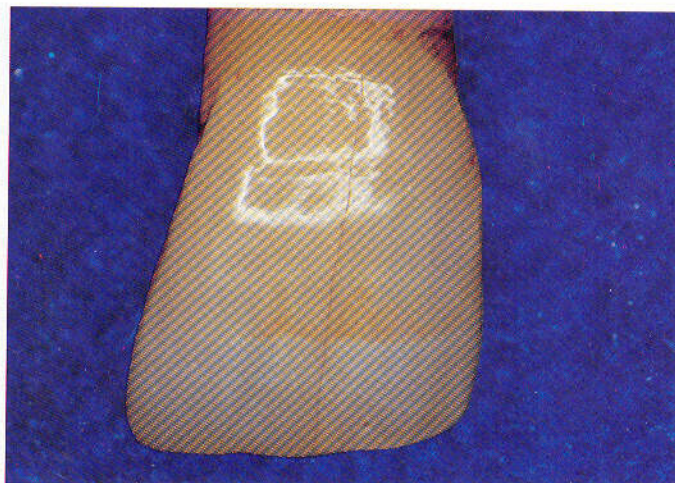


Fig. 11-19

The 35% orthophosphoric acid was placed on the distal half of the tooth for 60 seconds and then rinsed off.

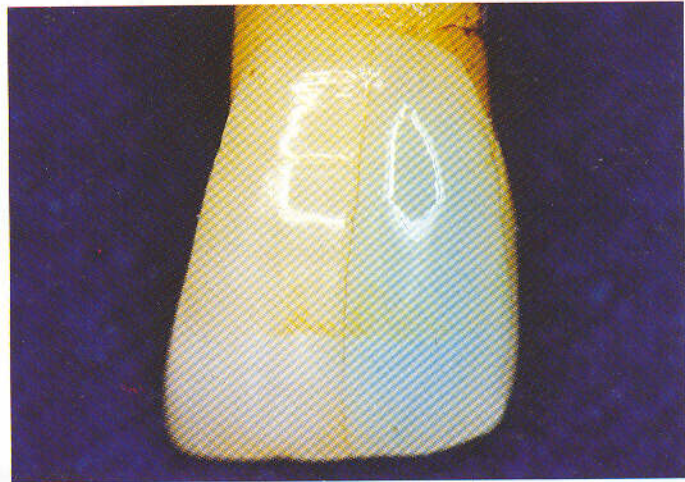


Fig. 11-20

The treatment could be shown schematically with the vertical lines showing where the tooth was sandblasted, and the horizontal lines showing the placement of the etchant. The crosshatched area indicated the overlapping of the two treatments.

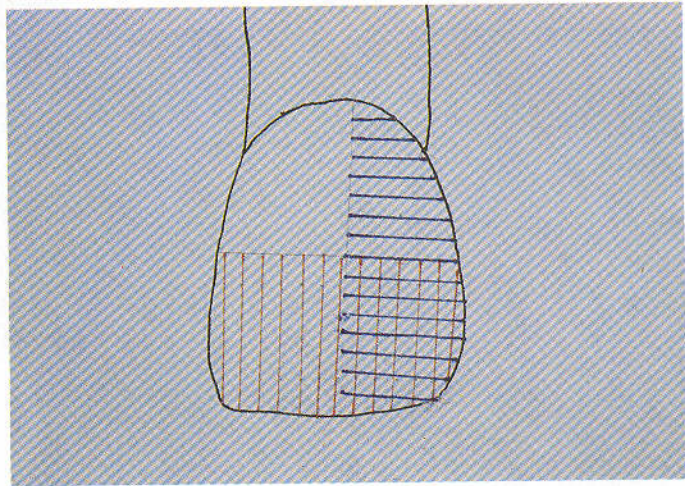


Fig. 11-21

Immediately after treatment, but before whitening, the tooth had this appearance.



Fig. 11-22

After 120 hours in the whitening liquid, several things are apparent (Figure 11-23):

1. The entire tooth is lighter in shade.
2. The etched area is lighter than the non-etched area.
3. The sandblasted area is lighter than the no-pretreatment section.
4. The lightest area is the one which was both etched and sandblasted.
5. The etched area lacks the glossy surface of the unetched area, and needs to be polished to regain its luster.

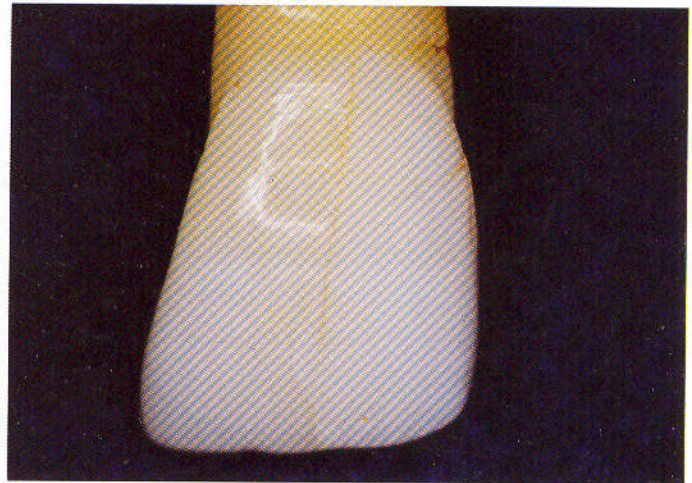


Fig. 11-23

Selectively slowing down the whitening

II. Selective Bonding. It is also possible to selectively slow down the whitening process. This can be done by bonding some clear composite resin over the area to be slowed down. As an example, another darkened extracted tooth was used.



Fig. 11-24

An area the shape shown in this schematic was to be covered with clear, unfilled resin.

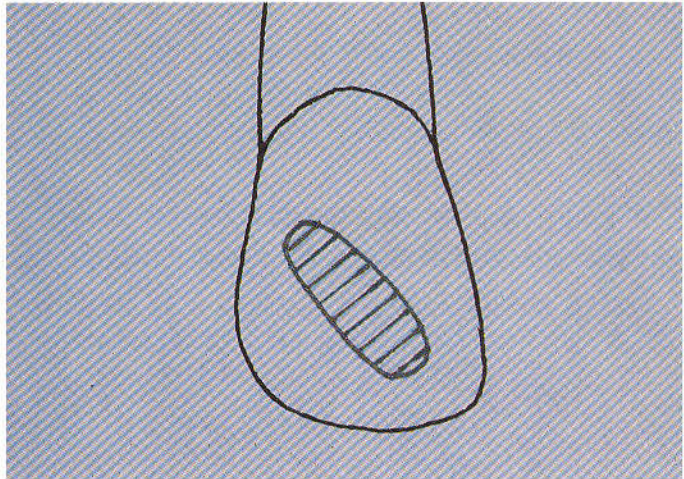


Fig. 11-25

In preparation for the bonding of the resin, 35% orthophosphoric acid was placed on an area which included slightly dark and extremely stained sections.



Fig. 11-26

Once rinsed and dried, the tooth looked like this.



Fig. 11-27

The frosted appearance disappeared with the placement of the unfilled resin.



Fig. 11-28

After setting the unfilled resin, and prior to placement in the whitening liquid, the tooth looked basically unchanged from the pre-treatment photograph.



Fig. 11-29

After 120 hours of tooth whitening, the appearance was drastically changed. The areas outside the resin coating are dramatically whitened, while the area covered by the resin seems hardly altered.

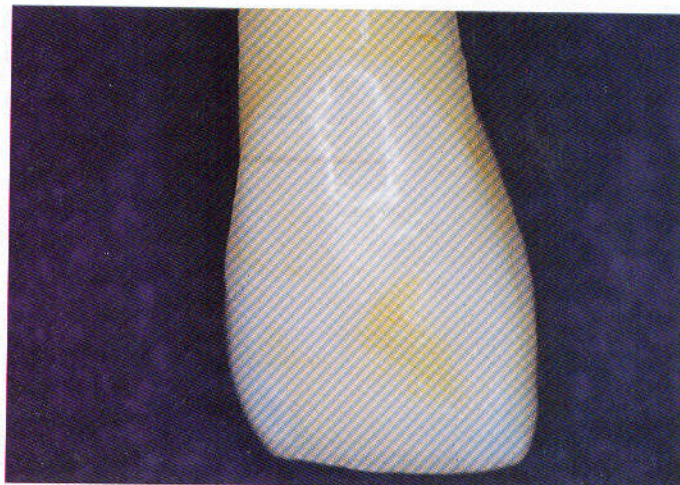


Fig. 11-30

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Chapter 12

Non-Vital Bleaching

Approximately 10% of all endodontically treated teeth become noticeably discolored with time.¹ This will sometimes result in a situation where all of the teeth match in shade except for an individual endodontically treated tooth. If the other teeth are a desirable shade, then only the endodontically treated tooth needs to be whitened.

It is possible to whiten a non-vital tooth using the home whitening technique, but this will also lighten the neighboring teeth. When finished, the teeth will all match (or at least match more closely) but they will match at a lighter shade than the patient presently exhibits. Sometimes this is desirable. Other times, such as when the other teeth include matching porcelain crowns, it would be undesirable to whiten the entire arch. The crowns would remain the present shade while the uncrowned teeth lightened. In such circumstances, a bleaching technique proposed by Nutting and Poe can often be used.² The technique utilizes a mixture of 30% hydrogen peroxide and sodium perborate sealed into the pulpal chamber between visits. Later researchers have shown that a weaker peroxide solution, such as twenty volume percent will also produce acceptable results. The fact that the bleaching takes place while the patient is not at the office has led to the name "walking bleach" for this technique.

Labial view of tooth to be bleached.

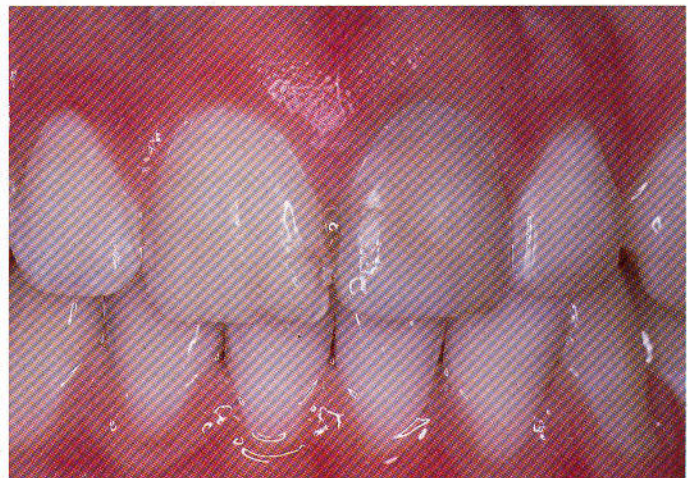


Fig. 12-1

To utilize the technique, access to the pulpal chamber needs to be made through the normal endodontic access-way. The coronal chamber is then cleansed completely, and extended if necessary to gain full access to all pulp horns. All vestiges of gutta percha, cement, fatty acids, and any necrotic pulpal remnants are carefully removed and the chamber is cleaned with a solvent. Grossly stained dentin can also be removed at this time.

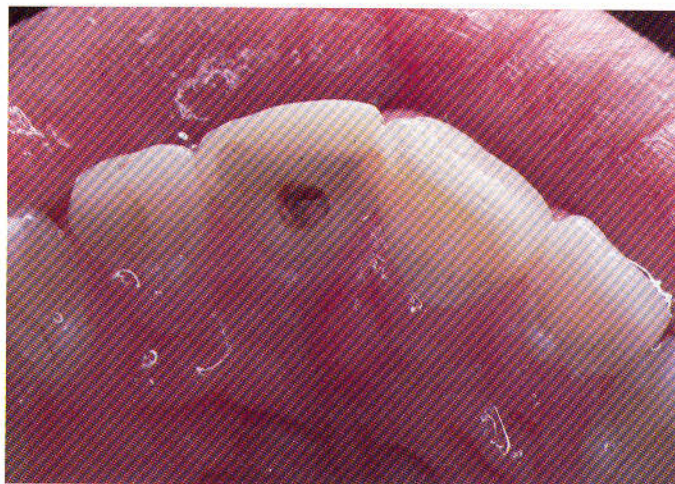


Fig. 12-2

Some disagreement exists as to the proper level for removal of root canal filling material. Ingle recommended eliminating endodontic filling material well below the level of the labial gingiva.³ Grossman recommended, however, that the endodontic filling extend only to the gingival margin.⁴ Further, Grossman felt that if the root canal filler is metal or paste, a portion of it should be ground away and securely covered with a thin layer of zinc oxyphosphate cement.

Whatever the depth selected, it is advisable to place a rubber dam for safety reasons before proceeding further. The chamber should be carefully rinsed and dried, and a paste mixture of peroxide and sodium perborate should be placed in the chamber. The chamber opening is then sealed with a suitable temporary cement.

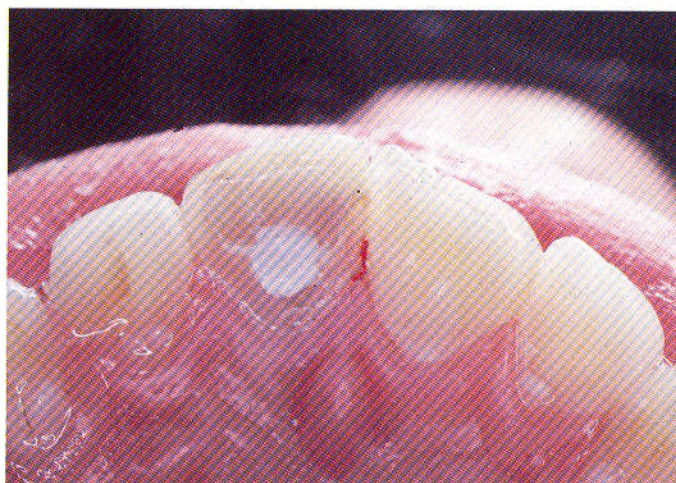


Fig. 12-3

It is important that the thickness of the cement be adequate to prevent breakage upon eating. It is also imperative that all openings to the chamber be hermetically sealed. Even slight leakage, around a bordering filling, for instance, will allow leakage of the chamber contents and the procedure will not be successful.

After about two weeks, the patient should return to the office and the procedure is repeated if necessary. These steps are repeated until the desired shade is achieved. When the bleaching is finished, the chamber is cleaned out and filled with tooth-colored composite.

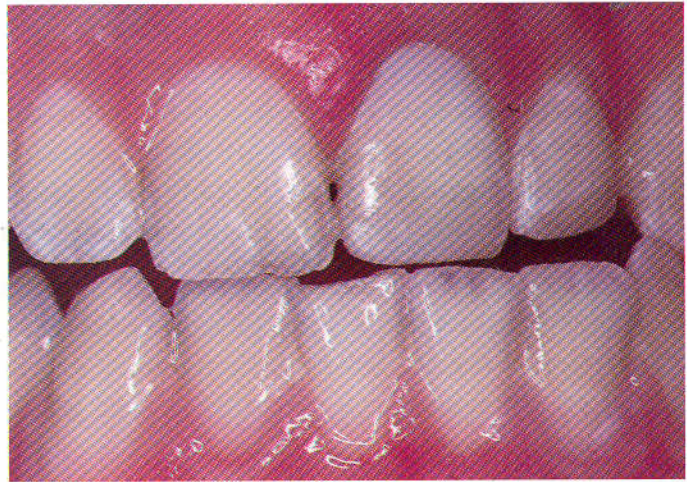


Fig. 12-4

This technique almost always results in at least some improvement, although a perfect match of the neighboring teeth is not always possible without bonding. As with other forms of tooth whitening, stains with a hue in the yellow/brown range are more quickly resolved than those of a blue/gray nature. On occasion, the tooth will bleach to the proper value (brightness) but never achieve the desired hue. This result can sometimes be adjusted through careful shade selection of the composite used for the final filling.

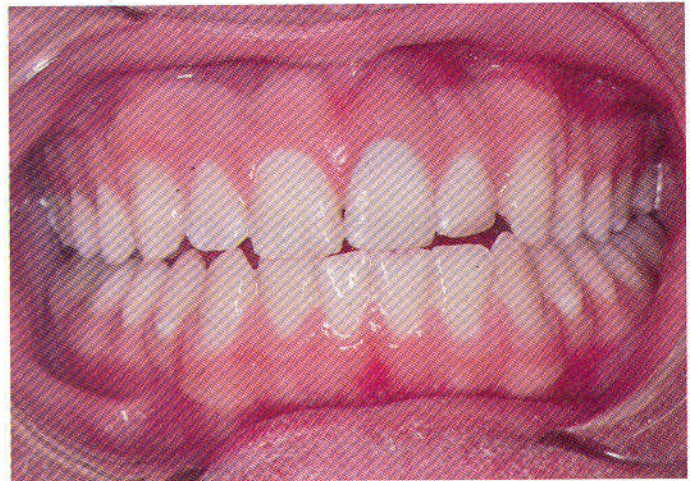


Fig. 12-5

There are three potential difficulties with this treatment method. The first is the lack of very long term stability. Feiglin reports that 55% of all cases treated with the walking bleach regressed in color over a six year period.⁵ One of their discoveries was that the more difficult it was to remove the discoloration, the more likely it was to return.

The second problem associated with the walking bleach is the possibility of external root resorption. When it occurs, the resorption is confined to the cervical portions of the teeth. Harrington and Natkin reported four cases of external resorption which were diagnosed between two and seven years after the bleaching procedure.⁶ Other authors have reported similar experiences.^{7,8,9}

While it is felt that trauma may play a role in the etiology of the external root resorption, it is now believed that the resorption is at least partly precipitated by a drop in pH in the cementum and surrounding tissues. It is for this reason that many practitioners believe the bleaching mixture should not be placed apical to the gingival margin. It is currently felt that if the bleaching mixture can be confined to areas which are supragingival, then the resorption can be prevented. Certainly further investigation is needed in this area.

The third potential complication of the walking bleach is the potential for severe apical pathology and reaction if the bleaching liquid is allowed to seep along the endodontic filling to the apical region. Severe inflammatory reactions, sometimes necessitating extraction have occurred when adequate precautions have not been taken. Such reactions can be entirely prevented by sealing the coronal aspect of the endodontic filling with zinc oxyphosphate or other, similar materials.

When appropriate, the "walking bleach" can be a dramatic, easy, and relatively inexpensive way to lighten the endodontically treated tooth.

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Afterword

Television Bleaching

As a direct result of the popularity of the home whitening systems, there has recently been an attempt to simplify the procedure to the extent that it can be performed without the need for professional supervision. To this end, several systems have begun to appear in advertising on television and in other media.

One typical example of such systems consists of three parts. The first part is primarily a mild acetic acid, commonly known as vinegar. The customer is directed by the manufacturer to swish the liquid around the teeth for a period long enough to initiate etching of the enamel surfaces, as well as any exposed dentin or cementum. This step may have some cleansing effect by dissolving slight surface stains. It also effectively roughens the surface of the tooth and opens any exposed dentinal tubules. Since slightly roughened surfaces dessicate more rapidly than unetched surfaces, the etched teeth immediately appear lighter when dried than they did prior to the acid rinse. One area of clinical concern, however, is the possibility of developing hypersensitivity as a result of etching exposed dentin or cementum.

The second step consists of the customer placing a jelly of hydrogen peroxide on the teeth with a cotton swab for a period of up to three minutes. This is the step which accomplishes any actual whitening. Unfortunately, since the whitening agent concentration is lower than the tray system concentration (1% vs 10%), we cannot expect the whitening to proceed as fast when compared to wearing a tray for an equal period of time (three minutes). Since the whitening action only really becomes perceptible after a minimum of several hours of contact with the peroxide in the tray system, we therefore cannot expect this home system to provide bona fide visible results for many months.

While the process can be accelerated by repeating the procedure more often than once a day, this approach carries with it some substantial risks. If the rate of decalcification and etching by the acetic acid becomes greater than the rate of re-calcification by the saliva, there will be a net loss of tooth structure. While this will be very slow, the results potentially could be catastrophic.

The final step in the process consists of burnishing a layer of very fine titanium dioxide into the etched surface. Titanium dioxide is an optically dense white pigment which is the main pigment used for white paints. Rubbing the titanium dioxide into the etched surface of the tooth has an effect similar to coating the tooth with chalk. It makes a noticeable, but transient, change in the shade of the tooth.

It is this third stage which allows the customer to feel that something has been accomplished. Since the pigment is gradually worn off the teeth over a period of hours, the customer may not notice that very little permanent change has really been achieved. Then, the next day, the treatment cycle is repeated.

While such systems seem to offer substantial savings to the customer initially, such savings really are an illusion since the customer must continue to purchase and use the product indefinitely. It is the opinion of the authors that in equi-effective doses, the dentist-supervised system actually is less costly to the patient than the over-the-counter remedies presently available.

Appendix A

Quick Guide to Clinical Steps

Patient evaluation

Clinical evaluation

- Look for cracks
- Look for leaky fillings
- Transilluminate teeth to be whitened
- Assay shade with patient and note
- Take baseline photos
- Try to ascertain cause of discoloration
- Ascertain patient expectations

Present treatment options

- Present prognosis
- Tell patient fillings may need to be changed after bleaching
- Make financial arrangements

Fill in cervical erosion

Replace needed fillings or caries where contours will change

Perform prophylaxis and scaling if necessary

Take impression

Deliver tray

- Check for fit
- Explain how to use tray
- Explain use of Omnii Med
- Explain use of Perio Med
- Give patient instruction sheet

Check one week later for progress

- If OK then continue as is
- If not, then perform prophylaxis and apply AFP for one minute

Appendix B

Quick Guide to Lab Steps

Pour up impression

Trim models to remove any border

Trim model to remove stone on lingual side

Place acrylic in vacuformer

Cut corners of acrylic sheets

Place shiny side up

Raise to within one inch of heating element

Place model on platform

Prepare accelerator (foam insert)

Cut the insert to be a smaller square than the acrylic

Cut "v" shaped notch for lingual side

Turn on heat

Acrylic will sag and wrinkle

Acrylic will smooth out and become nearly transparent

Place accelerator over model

Lower heated acrylic sheet over model and accelerator

Quickly turn on vacuum

Smooth out any wrinkles in acrylic with pencil eraser

Remove tray and model

Cut away gross excess with scissors

Cut exact outline with scalpel

Peel away excess from model

Lift off tray

Do final trim (if necessary) with fine scissors

Smooth any residual wrinkles with green stone

Deliver to dentist on model

Appendix C

Questions Most Often Asked by Doctors

Does tooth whitening work equally effectively on all teeth?

No. Some types of discolorations are more easily removed than others. Perhaps the teeth which benefit most rapidly and profoundly are those which have darkened with age. Other situations, such as darkening from dental alloys, or dark tetracycline stains are slower to respond. In some cases, it is not possible to achieve a perfect result, although it is unusual to have no improvement at all. The chapter on discolorations should be a help in predicting the effectiveness of home tooth whitening for any particular patient.

Will tooth whitening bleach all the teeth evenly?

Here we have both good news and bad. The bad news is that on some occasions the bleaching is not even. Some teeth may respond better than others, and occasionally some spotting can occur. The good news is that this is unusual, and that it is far more common to have an increase in the homogeneity of shade after whitening than before. Perhaps an apt comparison would be to say that the teeth being whitened act as does soiled fabric. When the soiled fabric is washed, it becomes clean and reverts back to its original color. If several soiled items were placed into the same washtub, those items which were most soiled would show the most improvement. At the end of the wash process, all the items would be back to their original clean state. If all the items matched in shade prior to becoming soiled, they will all match after being cleaned. It is usually the same with teeth. Those teeth which have darkened the most will usually display the greatest amount of whitening.

One other positive note: in the research performed at the University of Alabama using White & Brite, discolored teeth which only had a corner of the tooth soaked in the whitening solution showed whitening throughout the tooth. Thus, even though certain areas of the tooth may have longer contact with the whitening liquid (such as the incisal edge of the maxillary teeth), persistence with the whitening tray will result in an evenly whitened tooth.

Will the teeth turn an unnatural chalk-white from persistent application of the whitening liquid?

No. Perhydrol urea seems to be self limiting in its effect. Once again, the teeth act in a manner similar to clothes going into the wash. Once they are clean, repeated washings do not make them any cleaner. Similarly, once the teeth have achieved a bright natural whitening, they do not seem to show any increased whitening with repeated exposures.

Does home whitening remove white lesions?

No. Sometimes they become less noticeable because they will no longer be on a dark field, but they do not darken from tooth whitening procedures. See the chapter on tooth discolorations for suggested treatment.

How long do the teeth remain whitened?

The technique is so new that we do not know the limits of durability for the improvement. Over a two-year period, however, the results seem to be remarkably stable. If the patient should feel that the teeth are darkening again, it is an easy matter to simply place the whitening tray back in the mouth for a short while to return the shade to its original brilliance.

What side effects can be anticipated during treatment?

Remarkably few. There have been reports of tooth hypersensitivity, orthodontic-like discomfort, gingival irritations, sore throat from swallowing the peroxide, and sometimes nausea for the same reason. The number of patients suffering from these side effects is very small and the solution to the various problems is simple. For a more detailed discussion, see the chapter concerning clinical technique.

What is the biggest problem associated with this technique?

By far the biggest source of problems is that of incorrectly prepared trays. Wrinkles in the tray material, sharp edges, overextensions, and the like are usually the cause of any discomfort. These are easily prevented through proper laboratory technique.

Appendix D

Tooth Stain Chart

Cause of Discoloration	Period of Susceptibility	Color	Treatment Of Choice	Prognosis
Age	Post-eruptive	Yellow	Vital tooth whitening	III
Alkaptonuria	Pre-eruptive	Brown	Vital tooth whitening	III
Amelogenesis imperfecta	Pre-eruptive	Dull opaque white-dark brown	Full coverage or bond	I
Hypomaturation group	Pre-eruptive			
Hypocalcific group	Pre-eruptive	Smooth hard yellow	Full coverage	0
Hypoplastic group	Pre-eruptive			
Dental materials	Post-eruptive	Full range of colors	Vital tooth whitening	II
Dentinogenesis imperfecta	Pre-eruptive	Red-brown to gray opalescent	Full coverage	0
Endemic fluorosis	Thru age 9	Opaque white to dark brown	Vital tooth whitening	II
Erythroblastosis fetalis	Pre-eruptive	Brown to greenish-blue	Usually none necessary	0
Foods and beverages	Post-eruptive	Yellow to brown	Vital tooth whitening	III
Idiopathic pulpal recession	Post-eruptive	Yellow to brown	Vital tooth whitening	III
Porphyria	Lifetime	Red-brown (erythrodontia)	Vital tooth whitening	II
Sickle cell anemia	Lifetime	Brown to greenish-blue	Vital tooth whitening	II
Thalassemia	Lifetime	Brown to greenish-blue	Vital tooth whitening	II
Tetracycline	Thru age 9	Yellow to brown to gray	Vital tooth whitening	II
Traumatic injury				
Non-vital	Post-eruptive	From yellow to black	Non-vital bleaching	0
Vital, no resorption	Post-eruptive	From yellow to reddish	Vital tooth whitening	III
Vital, with resorption	Post-eruptive	Yellow, or pinkish spot	Non-vital bleaching	0

0 = No whitening necessary, or is contraindicated

I = Vital tooth whitening may help, but bonding will probably be necessary for perfection

II = Vital tooth whitening should be used, but bonding may be necessary for perfection

III = Ideal situation for vital tooth whitening